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PROGRESS IN SOIL AND WATER CONSERVATION RESEARCH

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Report for October-December 1956 Issued April 1957

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Alabama

ALFALFA GROWTH RATE DECREASES AS SEASON PROGRESSES

O. L. Bennett and R. W. Pearson, Thorsby.--Farmers and research workers in the Southeast have often ascribed the poor growth of alfalfa in the southeastern states during the late summer and fall to lack of adequate soil moisture during this period. Inasmuch as this has an important bearing on irrigation practice, an experiment was begun at Thorsby, Alabama, in 1954 to study this moisture problem. The rate of growth of alfalfa was followed throughout the season under conditions of adequate moisture.

Measurements were made of such climatic factors as incident light energy, air and soil temperature, and humidity in an effort to relate the observed growth rate of alfalfa to some measurable part of the plant's environment. The average daily growth rates listed below show that even when soil moisture is not limiting, there is a sharp change in the growth pattern as the season progresses.

Growth rate of alfalfa through the season, Thorsby, Ala., 1955-56

Month	Average daily growth rate per acre
	Pounds (dry weight)
May 20-31	78
June	59
July	68
August	30
September	16

A gradual decline in total incident light energy occurred as the season progressed, but the average daily temperature varied only slightly. The mean temperature ranged between 70 and 80 degrees with very few exceptions throughout the period of measurement. Light intensity dropped from an average of about 700 units per day during the early part of the season to only about 400 units per day during the latter part of the season. The 1955 data showed that both calendar date and light energy were significantly correlated with daily growth rate of the alfalfa. However, since both of these factors are related to day length, which itself is decreasing constantly from the beginning of the period of measurement to the end of the season, the data do not permit a specific explanation of the decrease in growth rate. For example, the light effect could be a changing day length influence on the physiological response of the plant rather than a total energy effect. Also, repeated cutting of the alfalfa may have produced a continued drain on the plant reserve which would be reflected in a lower vegetative growth rate during the latter part of the season. The study is being continued in an attempt to assign specific causes to the observed behavior of the crop.

The results obtained to date from this experiment indicate that supplemental irrigation of alfalfa during dry periods in the spring and early summer months should produce good growth response. Growth potential exists during this part of the season. Irrigation would be a questionable practice, however, during the late summer and fall.

Georgia

IRRIGATION INCREASES COTTON YIELD AND EFFICIENCY OF WATER USE

John F. Thornton and Edgar H. Wood, Watkinsville. --Data obtained in 1956 from cotton irrigation studies on Cecil sandy loam at the Southern Piedmont Experiment Station, show a marked increase in cotton yield from irrigation.

The irrigation variables for cotton included six levels of soil moisture as follows:

I_0 No irrigation

I_1 Irrigated when 100% available moisture is used from the top 24 inches of the soil

I_2 Irrigated 5 days after observed wilting

I_3 Irrigated when plants showed signs of wilting

I_4 Irrigated when 70% of the available soil moisture was used from the soil

I_5 Irrigated when 40% of the available soil moisture was used from the soil

Amount and source of water used and associated cotton yield, Watkinsville, Ga., 1956

Treatment	Source of water				Seed cotton yield	
	Rain	Irrigation	Soil moisture	Total	Per acre	Per inch of water
	Inches	*Inches*	*Inches*	*Inches*	*Pounds*	*Pounds*
I_0..............	8.10		3.05	11.15	1,952	175
I_1..............	8.10	5.76	2.46	16.32	3,621	222
I_2..............	8.10	4.32	3.19	15.61	3,306	212
I_3..............	8.10	4.32	3.47	15.89	2,911	182
I_4..............	8.10	8.64	2.86	19.60	3,463	177
I_5..............	8.10	11.16	3.74	23.00	3,257	141

These data show a significant increase in cotton yield from irrigation. There was an increase in efficiency of water use from the initial increments of irrigation water, but the cotton yield per inch of water from higher amounts of total water was somewhat less.

New Jersey

IRRIGATION INCREASES VEGETABLE YIELDS

G. D. Brill, New Brunswick. --In a study at Marlboro, cabbage, sweet corn, muskmelons, and canning beets were irrigated at three levels of soil moisture. These consisted of no irrigation, moderate irrigation (when 70 per cent of the available water was depleted) and frequent irrigation (when 30 per cent of the available moisture was depleted). The soil was brought to field capacity at each irrigation.

Rainfall during the 1956 growing season, April through October, was 24.22 inches, 3.95 inches less than the 15-year average. Distribution was quite uniform with no long dry period.

Vegetable crop yields from three levels of irrigation, New Brunswick, N. J., 1956

Crop	Yield per acre		
	Irrigation		
	None	Moderate	Frequent
	Tons	*Tons*	*Tons*
Cabbage	18.4	24.1	25.3
Sweet Corn	5.4	5.6	6.0
Muskmelons	21.6	21.0	19.8
Beets	4.5	6.0	6.4

Cabbage was irrigated twice under the frequent treatment using a total of about 3.0 inches of water. Cabbage was irrigated once, under the moderate treatment using a total of 1.6 inches of water. Both levels gave an adequate return for the water used.

Sweet corn was irrigated four times under the frequent treatment, and twice under the moderate treatment, using a total of 4.0 inches of water in each case. The yield increases were not enough to compensate for the added cost of irrigation. Quality of the sweet corn was slightly improved by irrigation. Muskmelons were irrigated twice under the frequent treatment with no effect on either yield or quality.

Beets grown under the moderate and frequent treatments were irrigated immediately after planting with .5 inch of water. In addition, the frequently irrigated beets received an additional one inch of water 10 days before harvest. With this crop the greatest benefit came from early irrigation to hasten germination, getting it off to a good start. The extra irrigation before harvest did not increase yield.

These results from irrigation at three levels of moisture tension show marked differences in consumptive use of water by these four vegetables. Cabbage yields were increased by six tons from irrigation, sweet corn yields were not increased enough to pay for the cost of irrigation, and muskmelons did not respond to irrigation. The timing of irrigation was the factor of greatest benefit for canning beets.

Texas

TIMELY IRRIGATION IMPORTANT FOR EFFICIENT WATER USE

Marvin E. Jensen, Willis H. Sletten, Amarillo.--Water use efficiency becomes a major concern where limited ground water supplies are being used for irrigation in the Texas High Plains. This term can be defined as the units of marketable crop produced for a unit depth of water used in evapotranspiration. Studies with grain sorghum at Amarillo show the importance of combining good water and fertilizer practices to obtain high yields and a maximum return for each inch of water applied.

The experiment herein reported was conducted on Pullman silty clay loam and consisted of 6 irrigation variables as main plots and various combinations of nitrogen and phosphorus as subplots. A preplanting irrigation applied to all treatments wet the soil to a depth of six feet. One additional irrigation was applied to all plots after planting to improve the strand. Maturity dates varied accordingly. Rate of seeding, cultivation and other cultural practices were the same for all plots.

Yields of grain sorghum as influenced by moisture and fertility levels are shown in the table below.

The effects of soil moisture and fertilizer on the yield of hybrid grain sorghum, Amarillo Experiment Station, Tex., 1956

Fertilizer treatment			Sorghum yield per acre						
			Moisture treatment[1]						Average
Number	Nitrogen	P_2O_5	M_1	M_2	M_3	M_4	M_5	M_6	
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
F_1.....	240	0	633	2,161	4,992	6,704	5,433	4,379	4,050
F_2.....	0	30	780	1,924	4,865	6,462	5,241	3,590	3,810
F_3.....	60	30	645	2,214	5,176	6,213	5,870	3,909	4,004
F_4.....	120	30	703	2,026	4,898	6,888	5,286	4,134	3,989
F_5.....	240	30	817	2,030	4,158	6,450	5,266	3,942	3,777
F_6.....	240	60	829	2,108	4,477	6,571	4,947	3,958	3,815
Average			735	2,077	4,761	6,548	5,340	3,985	

L.S.D.	5%	1%
Moisture means	508.2	702.8
Fertilizer means	N.S.	

[1] M_1 No additional irrigations. Rainfall from July through October, 5.08 inches, 4.36 inches below average.

M_2 One irrigation one week prior to boot stage.

M_3*Irrigated when weighted mean soil moisture tension approached nine atmospheres. One 4-inch application at late boot stage, August 6, and one 4-inch application at late milk stage, August 30.

M_4 Irrigated when weighted mean soil moisture tension approached four atmospheres. One 4-inch irrigation just prior to boot stage July 30, one 4-inch irrigation at early headstage, and a 4-inch irrigation at soft dough stage, September 4.

M_5 Irrigated when the weighted mean soil moisture tension approached one and one-half atmospheres. One 4-inch irrigation two weeks before boot stage, July 26, one 4-inch irrigation at boot stage, August 11, and one irrigation at milk stage, August 30.

M_6 Variable. Irrigated the same as M_4, except the September 4 irrigation was not given.

*The weighted mean tension was obtained by weighting the tension in quarters of the depletion zone by 4, 3, 2, and 1, consecutively, beginning at the top quarter.

No response to fertilizer applications was obtained. However, highly significant differences in yield between irrigation treatments resulted. Plots irrigated just prior to the boot stage, at early head stage and during the soft dough stage gave the highest yield. On the basis of these results, it would appear that the critical irrigation period for grain sorghum occurs sometime during the boot and fruiting periods. A comparison of treatments M_4 and M_6 indicate that a drastic reduction in yield can result from a soil moisture deficit during the soft dough stage of plant development.

The water use efficiency as affected by moisture treatments and total water used is shown in Figure 1. Total water use was greatest on the M_5 treatment and the return per inch of water used was somewhat less than that of the M_3 and M_6 treatments, which showed signs of wilting before irrigation, and considerably less than that of the M_4 treatment. The yield on the M_5 treatment probably would have been greater if the moisture level had been maintained later in the season.

The rate of water use for irrigation treatment, M_4 (Figure 2) indicates a peak use of 0.33 inches per day during the boot and early head stages.

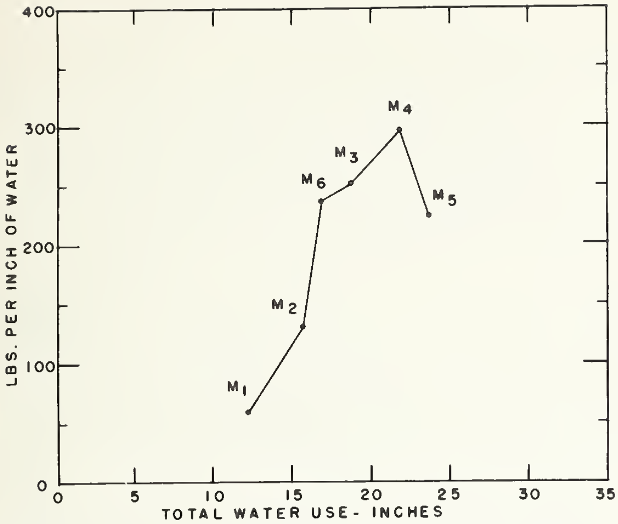


FIG.1 EFFICIENCY OF PRODUCING HYBRID GRAIN SORGHUM AS AFFECTED BY SOIL MOISTURE TREATMENTS. AMARILLO EXPERIMENT STATION, 1956.

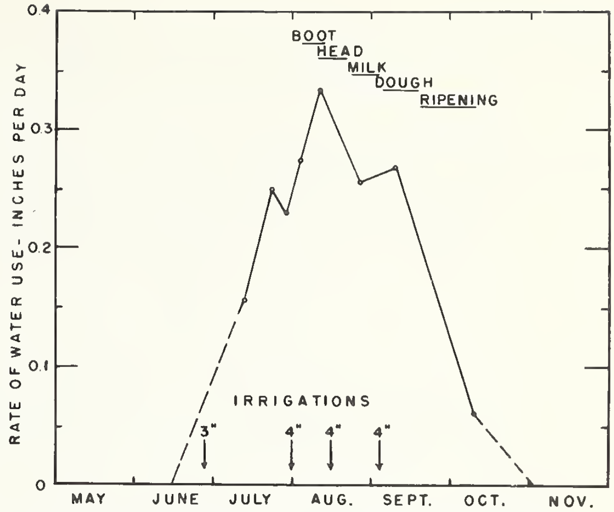


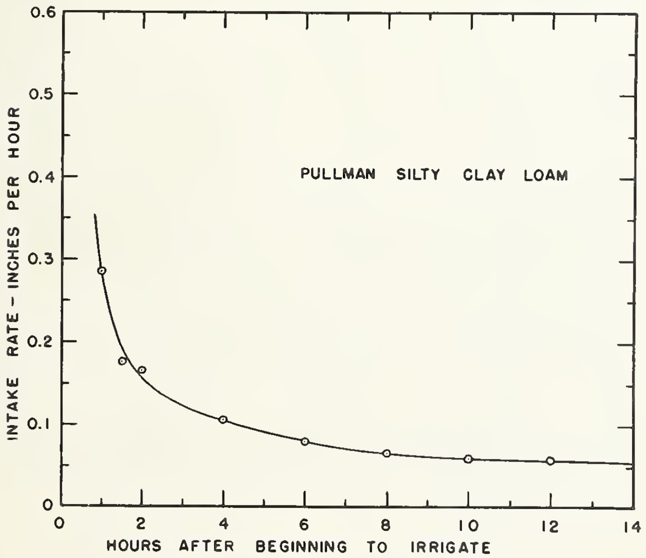
FIG.2 RATE OF WATER USE BY HYBRID GRAIN SORGHUM UNDER OPTIMUM IRRIGATION CONDITION, WITH TIME AND AMOUNTS OF IRRIGATIONS SHOWN. AMARILLO EXPERIMENT STATION, 1956.

Texas

STORAGE IN PLOW LAYER IMPROVES WATER PENETRATION ON "HARDLANDS"

Marvin E. Jensen, Willis H. Sletten, Amarillo. --Probably the major problem encountered in irrigating "hardlands," which have an ideal surface topography, is obtaining adequate penetration of irrigation water.

Three tillage treatments were used on irrigated wheat stubble in preparation for fall seeding of winter wheat. These treatments were (1) stubble mulch, chiseled 5-6 inches deep and sweep plowed 4-5 inches deep July 5, (2) moldboard, plowed 4-5 inches deep on July 12 and (3) rough, plowed 4-5 inches deep on July 12. All plots were sweep plowed 3-4 inches deep on July 26 and September 4 to control weeds, after which the stubble mulch and moldboard plots were floated prior to irrigating. Each plot was a level basin and water stage recorders were used to measure the intake rate.



INTAKE RATE DURING THE PREPLANTING IRRIGATION ON PULLMAN SILTY CLAY LOAM. AMARILLO EXPERIMENT STATION, 1956.

Intake measurements made in September 1956 showed no differences in the final intake rates under the different tillage methods after the plow layer was saturated. However, on plots that were worked deeper and left in a loose condition, initial intake rates were higher and water disappeared from the surface much more rapidly. This indicates that a temporary storage in the plow layer obtained by leaving this layer in a loose, cloddy condition is an important factor in obtaining better infiltration of irrigation water with a minimum of runoff on graded irrigation systems.

The average intake rate obtained from 9 plots is plotted in the accompanying figure. The final intake rate on all plots averaged 0.05 inches per hour after 16 hours.

Nebraska

BEAN PRODUCTION STUDIED ON LEVEL BENCHES

O. W. Howe and N. P. Swanson, Mitchell.--In the spring of 1956 field beans were planted on newly prepared level benches where the top soil was stockpiled and replaced over the irrigation surface. Sheep manure was applied at the rate of 15 tons per acre.

Pre-irrigation wet the soil to a depth in excess of 6 feet. No further irrigations were applied and rainfall during the growing season amounted to only 0.55 inches.

Soil samples indicated that the total amount of water required to produce 27.6 bushels of beans was 7.3 inches. In another experiment conducted the same year, four irrigations produced a yield of 54.3 bushels per acre. Water use efficiency, expressed as bushels per acre inch of water, was 3.9 bushels per acre with pre-irrigation plus rainfall, and 3.8 bushels with four irrigations plus rainfall. Thus, with good water management, production was nearly doubled without sacrificing efficient water use by this crop.

Beans receiving pre-irrigation only on level benches ran short of water during the pod filling stage. Yields undoubtedly would have been higher if irrigation water had been applied during this period. Further studies are planned to determine irrigation, fertility and cultural practices best adapted to crop production on level bench installations at this location.

Montana

WATER TABLE SUPPLIES WATER NEEDS OF ALFALFA

Ralph E. Campbell, Huntley.--Studies made at the Huntley Branch Station show that alfalfa can extract appreciable amounts of water for growth from a considerable depth in the soil.

With the water table at 6 to 9 feet below the soil surface, seasonal use of water exclusive of that arising from the water table was 28.0 inches (6 irrigations plus rainfall), 21.7 inches (3 irrigations plus rainfall), and 11 inches (rainfall alone). All irrigation treatments produced good alfalfa growth.

Mean yields of alfalfa hay produced over a 4-year period, 1953-56, are given in the following table.

Mean yields of alfalfa produced during a 4-year period under various irrigation treatments, Huntley, Mont., 1953-56

Irrigation treatment	Yield per acre			
	1st Cutting	2nd Cutting	3rd Cutting	Total
	Tons	*Tons*	*Tons*	*Tons*
Two irrigations between cuttings	2.36	1.42	1.69	5.47
One irrigation between cuttings	2.31	1.38	1.64	5.33
No irrigation	2.34	1.20	1.51	5.05
One irrigation early in season	2.45	1.30	1.49	5.24

It will be observed that production on the no irrigation treatment was almost as good as the moisture treatment receiving 6 irrigations plus rainfall. These data emphasize the importance of utilizing underground water supplies where favorable conditions exist. Often contributions of water from this source are overlooked and surface applications are continued simply because it is customary to do so.

No reduction in alfalfa stand developed during the course of the experiment. However, considerably heavier dandelion growth occured on plots which were frequently irrigated. The non-irrigated plots had practically no weed growth.

Nevada

WATER TABLE DEPTH AFFECTS CONSUMPTIVE USE AND YIELD OF ALFALFA

Victor I. Myers and Rhys Tovey, Reno.--Preliminary results from a tank study showed that consumptive use and yield were higher for alfalfa grown with a 3.5-foot water table depth than for alfalfa grown with either 2.0-or 5.0-foot depths to the water table. A water table is maintained at depths of 2, 3.5, and 5 feet below the ground surface in a series of evapotranspiration tanks. Alfalfa is grown in the tanks, with each water table depth replicated four times. Of the four replicates three are irrigated and one is non-irrigated. The tanks are surrounded by alfalfa to give conditions comparable to those encountered in the field.

Table 1 shows consumptive use and yield data for the various treatments for the second and third cuttings of alfalfa. Because of various difficulties encountered in maintaining water table conditions early in the season, data from the first cutting are not included.

TABLE 1.--Consumptive use and yield of alfalfa in lysimeters with water tables maintained at three depths Reno, Nev., 1956

Depth to water table	Daily consumptive use and yield of alfalfa			
	Second cutting of hay 7/11 to 8/29		Third cutting of hay 8/30 to 10/4	
	Average daily consumptive use for period	Yield per acre	Average daily consumptive use for period	Yield per acre
Feet	*Inches*	*Tons*	*Inches*	*Tons*
2.0	.35	2.04	.22	1.46
3.5	.41	2.55	.30	2.05
5.0	.41	2.37	.26	1.89

The data in Table 1 indicate that a water table close to the ground surface (2.0 feet) results in a reduced yield and less consumptive use of water. The relatively high values of yield and consumptive use from the 3.5 foot water table cannot be readily explained. All the tanks have uniform stands of alfalfa.

The data in Table 2 are presented to show the relation between consumptive use of alfalfa, evaporation from a United States Weather Bureau pan, and computed consumptive use using a standard method.

TABLE 2.--Relation between consumptive use by alfalfa and evaporation from a United States Weather Bureau pan, Reno, Nev., 1956

Peroid	Consumptive use*			Evaporation**	Ratio CU/E irrigated tanks
	Irrigated tanks	Non-irrigated tanks	Computed from Blaney-Criddle		
	Inches	*Inches*	*Inches*	*Inches*	*Percent*
7/11 to 8/29/56......	19.6	19.0	10.0	13.4	146
8/30 to 10/4/56......	9.7	8.6	5.1	7.6	128

*Consumptive use (CU).
**Evaporation from Weather Bureau pan (E).

The data show that consumptive use by alfalfa under conditions of a high water table is substantially greater than evaporation from a free water surface during the hot part of the growing season.

California

DECREASING INTAKE RATES OBSERVED IN IRRIGATED PASTURES

Norman A. MacGillivray, Berkeley.--Irrigation studies on strip checked irrigated pastures near Merced, California, indicate that intake rates decrease with time during an irrigation season. After several irrigations, a general decline in intake rates to less than one-half of the initial rate was observed on three pastures. Measurements on one pasture for two seasons located on Honcut silt loam showed the intake rate at the beginning of the second season had recovered to approximately the initial rate of the prior season. Data for three pastures are presented in the following table.

Average field intake rates for three irrigated pastures near Merced, California, 1955-56*

Irrigation number	Intake rate per hour			
	Pasture and year			
	No. 1--1955	No. 2--1955	No. 2--1956	No. 3--1956
	(Wyman clay loam over Yokohl hardpan)	(Honcut silt loam)	(Honcut silk loam)	(Marguerite silty clay loam over Madera hardpan)
	Inches	*Inches*	*Inches*	*Inches*
1......................	.144			
2......................	.108			
3......................	.105	.090	.130	.064
4......................	.128	.114	.150	.055
5......................	.104	.103	.072	.046
6......................	.132	.094	.109	
7......................	.178	.069	.092	.033
8......................	.086	.065	.083	.026
9......................	.102	.059	.086	
10......................	.042	.050		
11......................		.052		

*Average field intake rates determined by dividing inflow-outflow by the average intake opportunity time.

California

SAND FILTERS PROMOTE HIGH INFILTRATION

Leonard Schiff, Bakersfield.--Infiltrometer studies have shown that coarse sand filters are superior to pea gravel filters in reducing clogging of aquifers and maintaining infiltration for groundwater recharge operations.

The table shows the depth of water infiltrated in aquifer material with various overlying filter materials. Increased infiltration rates with the sand filter compared to the aquifer material without a filter are significant beyond the 5 percent level during the first run and beyond the 1 percent level during the second run. Further analysis shows that in all tests the coarse sand is the most effective in sustaining high infiltration rates, whereas the 1/8 inch pea gravel was significantly effective in only the second run, and the 1/4 inch pea gravel gave only small benefits in the second run.

Total infiltration of water in infiltrometers with various filter materials, Bakersfield, Calif., 1956

Filter material	First run 19 days	Second run 17 days	Third run 49 days
	Feet	*Feet*	*Feet*
No filter	1,672	303	5,255
Coarse sand	3,102	1,763	8,630
1/8" Pea gravel	1,679	523	--
1/4" Pea gravel	1,398	400	--

California

LARGE VARIATION IN EVAPORATION FOUND IN SAN FRANCISCO BAY

Dean C. Muckel, Berkeley.--Annual evaporation rates measured with Weather Bureau type pans vary from 106.50 inches at Tracy to 48.20 inches at Alviso, an airline distance of about 50 miles. Other stations throughout the region show similar differences with the rate of evaporation influenced greatly by exposure to the San Francisco bays and prevailing offshore winds.

The variation in rate of evaporation is much greater between locations than, from year to year, within any one location. At Davis (inland station) where continuous records have been maintained since 1927, the annual evaporation has varied from 90 to 112 percent of the long-time mean and at Newark (Bay Station) the annual evaporation has varied from 94 to 104 percent of the long-time mean.

The monthly evaporation expressed in percent of annual shows little difference between inland and Bay stations. The following table shows the monthly variation expressed in percent of annual for Davis (inland) and Newark (Bay).

Monthly variation in evaporation at base stations, Davis and Newark, for the period 1927-55 and the year 1949[1]

Period	Portion of annual evaporation occurring monthly											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Davis	(Inland station, average, annual evaporation 68.29 inch)											
1927-55	1.8	2.9	5.4	8.4	12.1	14.4	16.3	14.4	11.5	7.5	3.5	1.8
1949	3.0	2.3	4.4	9.5	11.3	15.5	16.3	13.0	11.1	8.8	3.3	1.7
Newark	(Bay station, average, annual evaporation 58.25 inch)											
1942-55	2.7	3.3	6.0	8.5	12.2	13.9	15.2	13.1	11.0	7.5	3.8	2.4
1949	3.6	2.9	6.2	10.0	11.8	14.7	14.0	11.9	10.9	8.5	3.1	2.4

[1] The year 1949 was maximum in evaporation at both base stations, being 112% of the 1927-55 mean at Davis and 104% at Newark.

California

PACIFIC COAST HAS A NEW CONSUMPTIVE USE STUDY

Harry F. Blaney and Paul R. Nixon, Los Angeles.--A consumptive use study of vegetation in the Santa Ynez River Basin of Coastal California is under way. Both irrigated crops and native vegetation will be studied. An end objective is to determine the contribution of rainfall and unused irrigation water to the ground water supply. A period of instrumentation and "tooling up" is now in progress.

The study is cooperative between the ARS, Santa Barbara County, U.S.G.S., U.S. Bureau of Reclamation, the Soil Conservation Service, and the soil Conservation Districts. Existing meteorological records of the area are being compiled for study. Additional meteorological stations are being established and a laboratory is already in operation. It is expected that results of this study will find wide application to West Coastal areas.

DRAINAGE

California

SAN LUIS SCD INVESTIGATING FEASIBILITY OF SHALLOW WELLS

Leonard Schiff, Bakersfield.--The San Luis SCD is investigating the feasibility of shallow wells for lowering the high water table in the area. A company making geophysical surveys in the area is supplying data they are obtaining on jet borings to 60 or more feet deep on 2,000 foot centers. A preliminary inspection of the data indicates the feasibility of a trial well. Beneath the soil mantle there is about 60 feet of sand in an appreciable portion of the area. There are indications that the water that may be pumped is of suitable quality for irrigation. Investigations are being continued on borings and water quality. A topographic map showing the present network of drainage ditches, most of which are clogged with vegetation, is being prepared for a study of the disposal system.

North Carolina

PLANT RESPONSE TO DRAINAGE TO BE STUDIED

Jan van Schilifgaarde, Raleigh.--A new basic research program relating crop growth to different regimens of drainage is being started at Raleigh. Recognizing that there is a

serious need for reliable criteria of what drainage rates are adequate for any crop under given conditions of weather, antecedent moisture, etc., it is planned to establish relations between growth, drainage and weather factors for at least one crop in this basic program.

Within a laboratory with controlled conditions of temperature, relative humidity and light, plants growing in soil will be subjected to different water table treatments. The effects of both water table height and of water table fluctuations upon the condition of the soil and upon the behavior of the plant, as affected by temperature and humidity, will be studied. Knowledge gained from this study will be used to formulate more realistic criteria than are now in use for determining the adequacy of drainage.

EROSION AND RUNOFF CONTROL

Indiana

RAINFALL SIMULATOR IN OPERATION

L. Donald Meyer and Donald L. McCune, Lafayette.--Two units of the newly developed rainfall simulator discussed in Quarterly Report No. 7 were constructed and tested during the past year.

Commercial spray nozzles (Veejet) were used to obtain the simulated raindrops. These nozzles were located eight feet above the soil surface, pointed downward, and oscillated across the slope. The water drops were applied intermittently to obtain intensities of 2.4 and 4.8 inches per hour. Approximately 80 percent of the kinetic energy of a two-inch per hour rainfall, as given by the Wischmeier and Smith rainfall energy equation, was obtained. The variation in intensity across the spray pattern was found to be less than 20 percent. Wind interference was not serious for winds up to 10 mph. Each unit of the apparatus covers an effective area 18 feet wide by 20 feet long. Units may be joined to increase the width and length. The twelve units now under construction will be

Figure 1. --Two units of the rainfall simulator on a 12-by 35-foot plot, Indiana, 1956.

Figure 2. --Plot surface during artificial storm of 2.4 inches per hour. Plot was 35 feet long on a 3 percent slope; runoff reached 2 inches per hour, Indiana, 1956.

capable of applying artificial storms simultaneously to three 12-by 75-foot plots with 6-foot borders.

The simulator has been designed to facilitate transportation and assembly. This will allow studies to be made on widely separated sites. Present plans call for individual or combined studies to determine soil loss, water loss, and infiltration as affected by length of slope, degree of slope, soil type, past erosion, seedbed preparation, tillage, and cover. Results are intended to be only comparative until satisfactory methods of using them for quantitative evaluation are found.

A number of runs with various surface conditions were made during October on the 12-by 35-foot plot shown in Figure 1. Although these runs were primarily to test the apparatus and various procedures, hydrographs and runoff samples were obtained for many of them. Limited information was gained for most combinations of (1) no surface cover and straw mulch cover, (2) worked up and not worked up surface, and (3) near field capacity and saturated conditions. Application intensity was 2.4 inches per hour on a Miami silt loam soil of 3 percent slope. All hydrographs except the one for the worked up, mulched, field capacity condition rose to near 2.0 inches per hour runoff and became essentially constant. The highest soil loss rate, 4.0 tons per acre per hour, occurred on the worked up, no cover, field capacity condition just as runoff became constant. Figure 2 shows this treatment during one run. The lowest soil loss, approximately 0.5 tons per acre per hour, occurred for the mulched, worked up, saturated condition.

The no cover condition produced more than twice the runoff and five times the soil loss as the mulched condition for thirty-minute water applications. The soil was worked up and near field capacity prior to the start of both runs.

Other indications were noted from the various runs, but all must be studied more thoroughly before conclusions may be drawn.

Once the simulator is perfected, it will be used to study effects of various management practices on erosion and runoff control, and the effect of length of slope, soil characteristics, etc., on erosion and runoff. Data such as these can be used to more firmly establish parameters in erosion formulas. The simulator should speed up accumulation of data over the regular runoff plot method which depends upon natural rainfall.

Oklahoma

WIND EROSION HIGH EVEN IN YEARS OF GOOD YIELDS

H. H. Finnell, Goodwell.--Field records of a soil moisture and ground cover study in the Great Plains from 1946 to 1951, inclusive, show this period to be one of fairly dependable crop production in the wind erosion areas inasmuch as there was no year of widespread wheat failure. Nevertheless, these records reveal that 4,330 fields experienced a measurable amount of soil erosion by wind out of a total of 17,680 recorded, or 24.5 percent. This is a substantial amount of erosion damage and should be of particular interest since it took place during a period not notorious for yield losses by drought.

A study of the factors associated with this erosion is summarized in Tables 1, 2, and 3. Highly significant relations between soil texture and erosion are indicated for soils coarser in texture than fine sandy loam. The presence of stubble mulch material on the surface of the soil at the end of the preparatory period showed beneficial effects where an average to abundant quantity was involved. Water conservation practices were effective where a considerable intensity of effort was indicated.

Other factors explored, but which showed no significant relationship to erosion, were the average rainfall per week; the length of the preparatory period, that is, the time elapsing between the harvest of the previous crop and the planting of the oncoming crop; and the amount of weed growth permitted to take place during the preparatory period.

TABLE 1.--Relation of soil texture to current erosion average per year in the Great Plains, 1946-51. Number of observations, N=6024. The correlation of soil texture on current erosion average was highly significant.

Soil class	Index of degree of erosion*
Clay loam	.93
Silty clay loam	.99
Silt loam	.88
Fine sandy loam	.96
Sandy loam	1.15
Loamy sand	1.20

*0 = No measurable erosion
1 = Slight erosion
2 = Serious erosion
3 = Severe erosion

TABLE 2.--Effect of stubble mulch on current erosion average per year in the Great Plains, 1946-51. Number of observations, N=5963. The correlation of stubble mulch on current erosion average was highly significant.

Amount of stubble left on surface	Index of degree of erosion*
None	1.16
Scant	1.11
Average	.81
Abundant	.62

*See foot of table 1.

TABLE 3.--Effect of water conservation practices on current erosion average per year in the Great Plains, 1946-51. Number of observations, N=6171. The correlation of water conservation practices on current erosion average was highly significant.

Intensity of practices (Index number)	Index of degree of erosion*
0	1.12
1	.81
2	.81
3	.83
4	.55
5	.29

*See foot of table 1.

Nebraska

CORN RESIDUE CAN BE A VALUABLE SOURCE OF NITROGEN

F. E. Koehler, Lincoln.--Nitrogen in the portion of a corn crop normally returned to the soil can contribute appreciably to the nitrogen supply for the following crops. From 20 to 67 pounds of nitrogen per acre were found in corn stalks and leaves, the amount being determined by the level of nitrogen in the soil and the rate of application of nitrogen fertilizer.

Yield of grain and nitrogen uptake by corn as influenced by rate of nitrogen fertilization were studied in five experiments on irrigated land in central and eastern Nebraska during 1956. Samples were taken for yield and chemical analysis after the shucks were well dried but while the leaves were still green from plots receiving different rates of nitrogen fertilizer. The results are summarized in the accompanying table. The application of 160 pounds of nitrogen per acre increased the concentration of nitrogen in the plants by 60 percent and increased the amount of nitrogen per acre in the plants by 100 percent for both the low to medium and the high nitrogen level soils. Lower rates of nitrogen fertilization produced smaller increases.

The importance of additional nitrogen in the crop should not be overlooked when assessing the returns from the use of nitrogen fertilizer. However, estimates from the above-ground residues may not indicate the entire amount of residue fertilizer nitrogen since some may be present in the roots and additional amounts may remain in the soil.

Effect of nitrogen fertilizer on yield of corn and the concentration and amount of nitrogen in the residue, Nebraska, 1956

Treatment	Soil nitrogen level					
	Low to medium*			High**		
	Yield	N in residue***		Yield	N in residue***	
△ #N/A.	bu./A.	%	lbs./A.	bu./A.	%	lbs./A.
0	69	0.51	20	111	0.54	33
40	103	0.58	25	135	0.69	48
80	116	0.66	31	142	0.74	52
160	121	0.81	39	138	0.90	67

*Average of 3 experiments.
**Average of 2 experiments.
***All above-ground portion of plants except ears.
△ Side-dressed as ammonium nitrate.

North Dakota

FERTILIZERS REDUCE EFFECT OF PRIOR MANURIAL PRACTICES

Howard J. Haas and Glennis O. Boatwright, Mandan.--Dryland rotations have been in operation at this station since 1914. Some of the rotations had received barnyard manure throughout the period, while others had received no soil amendments until 1955. Nitrogen losses from the 0- to 6-inch depth of soil over a 40-year period were slight from the manured rotations, but were as high as 35 percent from the non-manured rotations. In recent years there has been a wide range in wheat yields from these rotations, depending upon whether or not the land had been manured, whether the preceding crop was wheat or corn, or whether the land had been fallowed.

In 1955 and 1956, eight fertilizer treatments were applied to a number of the rotations and a summary of the results from five of the treatments is presented in the following table. The wide range in wheat yields which were obtained without fertilizers, can be observed from the results of the 0-0 treatment. The yields ranged from 16.7 bushels following wheat in non-manured rotations to 36.1 bushels following manured fallow. Where fertilizers were applied, maximum yields for each cropping treatment ranged from 34.4 bushels following corn in non-manured rotations to 38.1 bushels following manured summer fallow. In other words, under the conditions of this study, the wide range in wheat yields due to previous cropping or manure treatment was largely eliminated by fertilization. However, greater quantities of fertilizers were required on non-manured cropped land than on fallow or land which had been manured.

These results suggest that fertilized cropped land could replace summer fallow for wheat production, particularly in the more favorable rainfall years. They also suggest that by adequate fertilization, soils upon which soil depleting practices had been followed could be made to produce approximately the same as soils where fertility had been maintained.

The effect of various fertilizers on wheat yields following wheat, corn, and fallow in manured and non-manured rotations at Mandan, N. D., 1955-56

Manure in rotation	Year	Number of rotations	Wheat yield per acre				
			Fertilizer applied per acre*				
			0-0	0-40	20-40	40-40	80-40
			Bushels	*Bushels*	*Bushels*	*Bushels*	*Bushels*
			Following wheat				
None.............	1955	4	19.9	16.9	26.4	31.8	39.6
	1956	3	13.5	14.3	21.3	30.0	31.9
		Mean	16.7	15.6	23.9	30.9	35.8
Manured..........	1955	1	27.7	27.2	36.7	38.5	38.9
	1956	1	24.2	22.5	35.0	35.4	32.0
		Mean	26.0	24.9	35.9	37.0	35.5
			Following corn				
None.............	1955	3	22.4	26.1	32.1	33.6	37.7
	1956	3	16.6	16.4	25.6	30.0	31.1
		Mean	19.5	21.3	28.9	31.8	34.4
Manured..........	1955	2	36.3	36.5	37.8	40.6	36.3
	1956	2	27.6	28.9	31.0	34.0	28.9
		Mean	32.0	32.7	34.4	37.3	32.6
			Following fallow				
None.............	1955	2	32.0	37.0	40.9	38.1	36.7
	1956	3	28.8	34.4	32.5	35.7	32.5
		Mean	30.4	35.7	36.7	36.9	34.6
Manured..........	1955	1	36.3	41.5	41.1	36.7	36.7
	1956	1	35.9	**26.6	35.0	36.3	32.4
		Mean	36.1	34.1	38.1	36.5	34.6

*Pounds of nitrogen and P_2O_5 respectively.
**There was evidence of nitrogen deficiency on a low area of this plot, which was apparently due to leaching.

SURFACE SOIL MORE PRODUCTIVE THAN SUBSOIL

Carl W. Carlson and D. L. Grunes, Mandan.--A growth chamber experiment was initiated to compare plant growth response to nitrogen, phosphorus, potassium, manure, and minor elements on various horizons and mixtures of horizons of a soil profile. Bulk soil samples were collected from the different horizons of a Gardena loam profile from the Deep River Development Farm, Upham, North Dakota. Proportional amounts of the A_{1p} and B_1 horizons were placed in cans, certain treatments fertilized, and the cans seeded to barley.

Barley growth was greatest on the A_{1p} horizon at all fertilizer levels. Applications of nitrogen fertilizer increased yields on all horizons, but phosphorus additions did not. When both N and P were added, yields were greater than when either was added alone. Fertilization with minor elements increased yields on the A_{12} horizon while potassium sulfate increased yields on the B_1 horizon. In mixtures of horizons A_{1p} and B_1, and at all N and P rates, yields increased as the percentage A_{1p} increased.

The effect of fertilization on dry weight of barley, Upham, N. D., 1956

Fertilizer treatment per can N-P-K	Weight of oven dry barley per can						
	Soil horizon			Mixtures*			
	A_{1p}	A_{12}	B_1	4	3	2	1
Mgs.	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*
0-0-0........	3.94	1.58	1.15	3.81	2.95	2.09	1.55
240-0-0........	9.31	2.57	1.78	8.00	7.84	6.90	3.40
240-60-0........	10.42	7.61	7.34	9.45	9.42	8.31	7.71
240-120-0........	11.03	7.60	8.09	10.01	9.55	9.37	8.35
240-240-0........	11.67	8.14	7.73	10.40	9.84	9.46	8.18
120-240-0........	10.15	5.99	6.48	8.97	8.57	7.93	7.00
60-240-0........	7.31	4.71	4.71	6.70	6.37	5.66	5.89
0-240-0........	4.09	1.92	1.54	3.83	3.24	2.35	1.85
360-240-0........	11.29	7.75	7.81				
240-240-120........	11.30	8.62	8.99				
240-240-120+....... minor elements	11.91	9.89	9.15				
120-60-0........... + manure**	10.06	8.14	8.58				

*Mixtures were made up of horizons A_{1p} and B_1 in the following proportions: 1 -- 12 1/2% A_{1p} and 87 1/2% B_1, 2 -- 25% A_{1p} and 75% B_1, 3 -- 50% A_{1p} and 50% B_1, and 4 -- 75% A_{1p} and 25% B_1.

**Manure was applied at a rate of 24 tons dry manure per acre.

Results of chemical analyses of plant material showed that the amounts of total nitrogen in plant tops grown in horizons A_{12} and B_1 were similar, but were less than the amounts in the plants grown in the A_{1p} horizon. Yield increases observed on the nitrogen treatments, with increasing percentages of the A_{1p} in the mixtures, were due in large part to the greater phosphorus availability of the A_{1p} horizon. There was a tendency for the addition of B_1 soil to decrease the availability of fertilizer phosphorus to plants.

New Mexico

LEGUMES, FERTILIZER RAISE PRODUCTIVITY

Ross W. Leamer, State College.--Newly irrigated land in the arid country is seldom as productive as it can become. Lack of organic matter and other factors prevent maximum production in the first years under cultivation. Growing legumes, incorporation of manure, and the use of commercial fertilizers are means of increasing productivity of newly irrigated areas.

An experiment to determine the relative effectiveness of three legumes, manure, and inorganic fertilizer at increasing yields on newly irrigated Dalhart fine sandy loam was conducted at Tucumcari, New Mexico. The legume plots were the main plots of this split-plot experiment with fertilizer plots as subplots.

The area was benchleveled for irrigation in 1950. Winter wheat was planted to settle the newly formed benches and to give protection from spring winds. The fertilizers and manure were broadcast on the wheat stubble before plowing. Alfalfa, sweet clover, and hairy vetch were seeded to separate benches in the fall of 1951.

In the second year cotton was grown on the vetch and no legume plots. Alfalfa and sweet clover were harvested for hay. Yields obtained are given in Table 1. Fertilizers increased yields of all legumes over the unfertilized plots. Manure and P_2O_5 were equally effective in increasing vetch yields. Manure was better than P_2O_5 on sweet clover. The difference was intermediate on alfalfa. Nitrogen applied with P_2O_5 had no effect on yield of legumes. Cotton following fallow and vetch was also influenced by the fertilizers.

TABLE 1.--Crop yields as affected by fertility treatments, cropping system experiment, Dalhart fine sandy loam, Tucumcari, N.M., 1952.

Treatment (Fall, 1951)	Crop yields per acre				
	Alfalfa	Sweet-clover	Hairy vetch	Seed cotton*	Seed cotton**
	Tons	*Tons*	*Tons*	*Pounds*	*Pounds*
Check	2.34	1.53	1.59	3,020	2,450
Manure, 20 ton per acre	5.74	3.53	3.90	3,380	3,180
P_2O_5, 200 lb. per acre	5.04	2.50	3.85	3,600	2,770
40 lb. N and 200 lb. P_2O_5 per acre	5.05	2.70	3.80	3,190	2,670

*Following hairy vetch.
**Following no legume.

Grain sorghum was grown in 1953, 1954, and 1955 to determine the residual effects of the legumes and fertilizers. The final 160 pounds of N on treatment 4 were applied when the sorghum was planted in 1953. No fertilizers were applied after 1953. The yields obtained are given in Table 2.

These data show that the first crop of sorghum following the variable cropping was affected equally by several of the treatments. All the fertilized legumes, whether fertilized with manure or inorganic fertilizer, gave essentially equal yields. Inorganic nitrogen and phosphorus without a legume gave equally high yields. The unfertilized legumes and the two fallow treatments without inorganic nitrogen were less satisfactory. These observations indicate that both nitrogen and phosphorus were necessary for satisfactory yields of sorghum on this soil. Ample amounts of these elements were available to the sorghums where phosphorus was applied to the legumes. Nitrogen in the manure was not as effective as inorganic nitrogen on this first year of sorghum. Where phosphorus had been applied to the legumes no benefit was observed from nitrogen fertilizer. As noted above, the legumes responded differently to manure and inorganic phosphorus. These differences in legume growth did not affect the 1953 sorghum yields.

The second (1954) crop of sorghum showed some different responses to the cropping systems and fertilizer practices. The manured alfalfa plot yielded as much sorghum in 1954 as it did in 1953. The phosphated alfalfa plots with and without nitrogen also produced good yields in 1954. These three, along with the manured sweet clover, were the highest producing plots in the group. The other plots showed some advantage from the use of nitrogen with the legumes. Manure averaged slightly better than inorganic nitrogen

TABLE 2.--Residual effects of legumes and fertilizer treatments on yield of sorghum, cropping system experiment, Dalhart fine sandy loam, Tucumcari, N. M., 1953-55. (All fertilizer applied in the fall of 1951 except as indicated).

Crop in 1952	Sorghum yield per acre			
	Fertility treatment per acre			
	Check	Manure 20 tons	P_2O_5 200 lb.	N:200 lb.* P_2O_5:200 lb.
	Bushels	*Bushels*	*Bushels*	*Bushels*
	1953			
Alfalfa..........................	58.4	83.0	80.9	83.0
Sweet Clover....................	60.8	81.5	77.2	74.4
Vetch............................	57.0	82.0	81.1	80.1
Fallow...........................	47.9	64.5	59.2	81.2
	1954			
Alfalfa..........................	63.3	86.8	78.1	82.9
Sweet Clover....................	43.1	82.0	58.1	69.8
Vetch............................	49.8	64.0	64.5	66.3
Fallow...........................	39.5	61.0	49.2	54.2
	1955			
Alfalfa..........................	36.3	49.8	40.1	48.4
Sweet Clover....................	29.3	48.7	36.6	37.3
Vetch............................	31.4	46.6	42.9	46.3
Fallow...........................	24.5	38.0	35.2	35.2
	Three year total			
Alfalfa..........................	158.0	219.6	199.1	214.3
Sweet Clover....................	133.2	212.2	171.9	180.6
Vetch............................	138.2	192.6	188.5	192.7
Fallow...........................	111.9	163.5	143.6	170.6

*160 lbs. of this nitrogen applied at sorghum seeding in 1953.

even though the manure was applied in 1951 and inorganic nitrogen in 1953. After the variable cropping system treatments, the benches were no longer level and it was necessary to over-irrigate some plots in order to irrigate others adequately. The change in the relative yield of manured fallow plot and the fallow plot receiving inorganic nitrogen may be due to leaching of the inorganic nitrogen or to a release of more nitrogen from the manure. The low yield of the plots receiving phosphate only on fallow indicates that some nitrogen was being supplied from the legumes grown two to three years previously. The fertilized legumes apparently supplied more nitrogen than did the manure applied in 1951.

All third year sorghum yields were low. The manured plots averaged higher than the others, with inorganic nitrogen only slightly lower. Nitrogen applied to the legume plots tended to increase all 1955 yields. The increase from inorganic nitrogen on sweet clover plots was very slight.

New Mexico

SORGHUM HEADS CONTAIN MORE N AND P THAN STALKS

James A. Burr, Tucumcari and Ross W. Leamer, State College.--The chemical analysis for grain sorghum plants grown in 1955 in a residual phosphate study has been completed and the data show the sorghum heads contain about twice as much N and about three times as much P_2O_5 as do the sorghum stalk.

An experiment comparing the carry-over effect of five rates of P_2O_5 was started in 1951 on a new seeding of alfalfa. The soil type was Springer fine sandy loam and the rates of P_2O_5 used were 0, 60, 120, 240 and 480 pounds per acre. The treatments were replicated four times. These plots were plowed down in the spring of 1955 and divided in half. One half was fertilized with 120 pounds of nitrogen per acre and the other half was left unfertilized. The entire area was seeded to grain sorghum and irrigated five times during the 1955 crop season. Plant samples were collected from each plot in the fall of 1955 and the stalks and heads were separately ground and analyzed for nitrogen and phosphorus content. A summary of these analyses is presented in the following table.

Grain sorghum yields and nutrient uptake as influenced by the application of N and P_2O_5. Tucumcari, New Mexico, 1955.

Treatments per acre		Yield per acre		Uptake of nutrients per acre					
1955 N	1951 P_2O_5	Grain	Stalks	N			P_2O_5		
				Head	Stalk	Total	Head	Stalk	Total
Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
0	0	2817	4031	41.1	23.4	64.5	9.5	5.0	14.5
120	0	3114		49.2	29.0	78.2	11.0	3.8	14.8
0	60	3318	3873	49.1	22.8	71.9	11.7	4.4	16.1
120	60	2991		45.5	27.1	72.6	9.7	3.8	13.5
0	120	2993	4163	58.3	27.5	85.8	15.0	4.9	19.9
120	120	2731		59.3	32.0	91.3	13.4	5.3	18.7
0	240	4581	4742	67.8	32.7	100.5	16.7	5.7	22.4
120	240	4632		69.9	37.5	107.4	18.6	5.8	24.5
0	480	6135	5480	84.0	44.3	128.3	35.8	12.6	48.4
120	480	6403		100.5	45.5	146.0	37.0	9.1	46.1
Ave.	--	--	--	62.5	32.2	--	17.8	6.0	--

Inspection of the above table shows that the amounts of N and P_2O_5 removed by the sorghum plant progressively increase as the 1951 phosphate rates increase. The data also point out that approximately 120 pounds of nitrogen and 45 pounds of P_2O_5 are needed in the plant to produce 6,000 pounds of grain sorghum and that the major portion of these two nutrients is deposited in the sorghum head. The ratio of these two nutrients brought out by these analyses correlates very closely with the fertilizer recommendations that have been given in the Tucumcari area for high grain sorghum production.

Oregon

NITROGEN SOURCE, APPLICATION METHOD AFFECT WHEAT YIELD

C. J. Gerard and M. M. Oveson, Pendleton.--In 1955 an experiment using different nitrogenous fertilizer sources on winter wheat was initiated at the Pendleton Branch Experiment Station. The results in 1956 from this experiment indicate: (1) The best rate of nitrogen to apply in the Pendleton area is approximately 40 pounds per acre. (2) Different sources of nitrogen responded differently to the method of application. (a) Calcium nitrate and ammonium nitrate which are sources containing nitrate-nitrogen gave best wheat yields when top-dressed. (b) Applications of sodium nitrate produced better yields when it was placed below the soil surface. The top-dressed applications of sodium nitrate caused sealing of the soil surface and subsequent loss of some of this material with surface runoff. (c) The ammonium-nitrogen sources gave best response in 1956 to sub-surface applications. There was no significant difference in winter wheat yields resulting from the application of anhydrous and aqua ammonia. The top-dressed ammonium-nitrogen plots, ammonium sulfate and urea, yielded less than plots treated with anhydrous and aqua ammonia at the 40-pound rate of nitrogen. All fertilizer applications were made in the fall of 1955.

Effect of application method and different nitrogenous fertilizer sources on winter wheat yields at the Pendleton Branch Experiment Station near Pendleton, Oregon, 1956.

Treatment	Yield per acre		
	Nitrogen per acre (Pounds)		
	None	40	80
	Bushels	*Bushels*	*Bushels*
Check	43.6	--	--
Calcium Nitrate top-dressed	--	64.3	68.4
Calcium Nitrate applied at 3 to 6 inches	--	65.5	65.4
Ammonium Nitrate top-dressed	--	69.8	72.2
Ammonium Nitrate applied at 3 to 6 inches	--	63.1	63.4
Sodium Nitrate top-dressed	--	63.8	64.9
Sodium Nitrate applied at 3 to 6 inches	--	67.0	66.0
Anhydrous Ammonia applied at 3 to 6 inches	--	67.6	64.0
Aqua Ammonia applied at 3 to 6 inches	--	69.6	67.2
Ammonium Sulfate top-dressed	--	58.2	68.4
Urea top-dressed	--	60.1	66.9

Rates (40 vs. 80 # N/A) = N.S.
Sources x Method of Application = Sig. (0.01)
L.S.D. (0.01) Treatment = 7.7 bu/acre
L.S.D. (0.05) Treatment = 5.7 bu/acre

Oregon

SHANK APPLICATIONS OF NITROGEN INCREASE WHEAT YIELDS

C. J. Gerard and M. M. Oveson, Pendleton. --A field experiment was initiated in which anhydrous ammonia and ammonium nitrate were placed 4 to 6 inches deep in growing wheat in the spring of 1956 at the Hill Pilot Farm near Helix, Oregon. The wheat was about four inches high at the time of application. These materials were applied at rates of 30 and 60 pounds of nitrogen per acre. Yield responses were compared with those resulting from top-dressed applications of ammonium nitrate at similar rates. The Elmar winter wheat was seeded in mid-October of 1955 on stubble mulch tilled land. The fertilizer treatments were applied on March 30, 1956.

The results tabulated in the table indicated: (1) Shank applications of fertilizer materials in the spring on winter wheat do not reduce wheat yields. (2) Significant responses were obtained from 30 and 60 pounds of nitrogen per acre on Walla Walla soil near Helix, Oregon, with 60 pounds of nitrogen per acre being the most economical rate. (3) Placement applications of nitrogen fertilizer in the spring of 1956 on winter wheat appeared to be slightly better than top dressed applications.

Results of spring applications of anhydrous ammonia and ammonium nitrate on the yield of winter wheat at the Hill Pilot Farm near Helix, Oregon, 1956.

Treatment	Average Yield per acre
	Bushels
Check	28.1
Check with shank applicators dragged through wheat(4-6" deep)	29.1
30# N/ac-NH_4NO_3 top dressed	34.7
30# N/ac-NH_4NO_3 applied 4-6" deep	37.7
30# N/ac-NH_3 applied 4 to 6" deep	38.5
60# N/ac-NH_4NO_3 top dressed	40.9
60# N/ac-NH_4NO_3 applied 4-6" deep	42.1
60# N/ac-NH_3 applied 4 to 6" deep	42.0

Sources=N.S. L.S.D. (0.05) = 3.8 bu./acre
Top dressing vs. placing=N.S. L.S.D. (0.01) = 5.2 bu./acre

CROPPING SYSTEMS

New York

COVER CROPS AID CORN HARVESTING

G. R. Free, Ithaca. --Farmers in New York are confronted with the problem of harvesting corn and dried beans when the soil moisture is at a high level in late fall. Sometimes these crops are left in the field over the winter with partial or total loss because the wet soil will not support the tractor and harvesting equipment.

A tractor and one-row corn picker cut ruts 4.5 to 7 inches deep at corn picking time on plots at Marcellus in 1956. On plots seeded to ryegrass at the last cultivation of corn the tractor and picker cut to a depth of only 1 to 2 inches. Average depth of ruts was 5.4 inches for the control plots and 1.1 inches for those with ryegrass. These records were obtained from over 200 corn plots in late November when the soil was very wet.

The cover crop not only protects the soil but in some years may make the difference between a relatively easy harvest and partial or total loss of the crop.

New York

BIRDSFOOT TREFOIL RESPONDS TO INOCULATION

G. R. Free, Ithaca.--A uniform legume inoculation study on "Viking" birdsfoot trefoil shows that this legume responded to effective inoculation at the Marcellus Station. The soil was Honeoye silt loam, moderately high in organic matter with a pH of 7.0 to 7.2. Birdsfoot trefoil had not been grown previously on the two sites where the plots were located. The areas were liberally fertilized with phosphate and potash.

The plot treatments and yields (on an oven-dry basis) for two cuttings made the year following spring seeding are given below:

Source of inoculation	Yield per acre*	
	Seeded	
	1954	1955
	Tons	*Tons*
None	1.04	2.80
Soil inoculant	1.55	2.75
Commercial culture	1.55	3.20
Special culture	1.45	3.26

*Each of the yields given is the mean of 8 determinations.

Both site and rainfall were more favorable for the 1955 seeding than for that made in 1954. Also, the plots seeded in 1954 were rather weedy when harvested in 1955, and the yields given are based on birdsfoot plants separated by hand.

The "special" inoculant was a strain which had been tested and selected for superior performance at Beltsville. The "soil" inoculant was local soil from around roots of large vigorous growing plants. All three inoculants were applied to the seed.

Similarity of the "special" and "commercial" inoculants is clearly evident. Yields exceeded those for the un-inoculated treatment by nearly one-half ton per acre. Examination of roots showed the high yielding plants to be well nodulated. Some plants on the check plots bore nodules which were small and apparently not very effective. The "soil" inoculant ranked high in the 1954 seeding, but produced less than the un-inoculated treatment in the second trial.

Nitrogen was applied to half the plots each year at the rate of 30 pounds per acre. The nitrogen increased yields slightly under check treatments, but did not show any benefit on the inoculated plots.

This experiment proved the reliability of inoculants prepared in the laboratory and also revealed the chances a farmer takes if soil from around nodulated roots of birdsfoot trefoil is used to inoculate seeds of this legume. Syrup was mixed with the water used to moisten seeds for half the plots, and only water was used for the other half. The syrup had little or no effect on results.

Colorado

ALFALFA IN CROP ROTATION INCREASES YIELD OF CORN

M. Amemiya and C. W. Robinson, Grand Junction. --One of the objectives of a rotation fertilizer experiment established in 1954 near Grand Junction is to determine the effect of alfalfa in a cropping system on the yield of corn. Cropping systems under consideration are a 3-year rotation of corn, sugar-beets, and barley, and a 6-year rotation of corn, sugar-beets, barley and 3 years of alfalfa. In the latter rotation, the third cutting of the third year alfalfa is plowed under.

Data for 1955 and 1956, as shown in the accompanying table, indicate that corn following alfalfa yielded significantly greater amounts of grain and total dry matter than corn following barley, regardless of fertilizer treatment. Increased yields from the fertilized plots in both rotations were attributed not only to the fertilizer applied to the corn but also to the effects of that applied to the preceding crop. In the case of the 6-year rotation there appears to be a correlation between the amount of alfalfa plowed under (a function of the amount of phosphate fertilization) and the growth of corn.

The effects of alfalfa in a rotation are being studied also in terms of differences in soil physical condition. Observations and preliminary aggregate stability data indicate more favorable soil structure and tilth as a result of plowing under alfalfa. This physical change, affecting soil-air-water relationships, coupled with the contribution made by alfalfa to the soil nitrogen economy, are believed to be the major benefits of including alfalfa (or other deep-rooted legumes) in a cropping system.

Yield of grain and total dry matter of corn as influenced by preceding crop, 1955-56. Grand Junction, Colorado.

Fertilizer treatment	Corn grain[1] per acre				Total dry matter per acre			
	Corn after alfalfa		Corn after barley		Corn after alfalfa		Corn after barley	
	1955	1956	1955	1956	1955	1956	1955	1956
	Bushels	*Bushels*	*Bushels*	*Bushels*	*Tons*	*Tons*	*Tons*	*Tons*
Unfertilized[2]............	110.6	105.0	80.7	99.0	7.53	6.66	6.01	5.50
Fertilized[3]..............	118.4	127.7	92.5	98.6	7.55	7.02	6.37	5.29
Average of all plots.....	117.3	124.5	91.0	98.8	7.55	7.10	6.33	5.32

[1] 15.5 percent moisture.
[2] Preceding crop was unfertilized also.
[3] Average of 7 treatments.

RESIDUE MANAGEMENT

Nebraska

O. M. IN SURFACE INCREASED SLIGHTLY BY STUBBLE MULCHING

T. M. McCalla, Lincoln. --On plots stubble mulched for 18 years at the Agronomy Farm at Lincoln, there has been a slight build-up of organic matter in the surface inch of soil as compared with moldboard plowed plots. The data are summarized in the accompanying table. On these plots the residues grown were returned and either left on the surface with stubble mulching or turned under with plowing.

Some farmers have indicated a concern that organic matter may accumulate with stubble mulching to the extent of interfering with tillage operations. The slightly slower rate of decomposition of crop residues with stubble mulching, as compared with plowing, probably accounts for the slightly higher organic matter observed.

Influence of stubble mulching on the organic matter of the soil, Lincoln, Neb.

Treatment	Organic matter content of soil			
	Subtilled		Plowed	
	Depth 0-1"	Depth 1-6"	Depth 0-1"	Depth 1-6"
	Percent	*Percent*	*Percent*	*Percent*
In corn..................................	3.8	3.7	3.5	3.7
To wheat.................................	4.0	3.9	3.8	3.8
1st yr. corn after 2nd yr. sweet clover..	3.9	4.1	3.8	3.6
1st yr. corn after 1st yr. sweet clover..	3.9	3.7	3.6	3.6

Maryland

MULCH TILLAGE TRIALS RECOMMENDED IN HUMID REGION

R. R. Robinson, Beltsville.--Field trials to evaluate mulch tillage in the Eastern half of the country were recommended at the mulch tillage conference held at Beltsville, January 22-24, 1957. It was recognized that although a number of problems need further study, the value of mulch tillage in erosion control is so great that it should be tested under actual farm conditions.

The basic concept of mulch tillage involves the use of crop residues as mulches - a practice highly effective in controlling runoff and erosion. The detailed procedures vary depending upon soils and cropping systems. For corn following corn in the midwest, for example, sweeps will effectively till the soil while leaving crop residues on the soil surface. However, sweeps cannot be used on hard stony ground and they are not effective in killing grass sods. The double-cut plow is one of the most promising tillage implements for killing heavy grass sods while at the same time utilizing the sod as a mulch for row crops.

Mulch tillage is widely practiced in the semi-arid parts of this country, where it is better known as stubble mulch farming. The practice greatly decreases both wind and water erosion.

In the more humid parts of the country, mulch tillage has not been generally recommended because usually no increase in crop yield is obtained and often yields have been slightly lower than under conventional tillage. But in recent years, with improved techniques for control of weeds and with proper fertilization, high crop yields have been obtained on most soils under mulch tillage. On soils that are wet and cold in the spring, mulch tillage presently is not recommended.

Fundamental research on mulch tillage is being continued. As new facts come to light, improvements in the recommended practice will be made. Factors such as temperature, microbiological and plant nutrient inter-relationships, and soil tilth under mulches will be further investigated in the fundamental studies.

South Carolina

EVAPORATION AND SEEPAGE REDUCED BY PLASTICS

O. W. Beale and S. A. Nunnery, Clemson.--A polyethylene cover to control loss by evaporation and a plastic liner to control loss by seepage were effective in controlling these losses for a small dug pond in South Carolina during the fall of 1956. This use of plastics appears to have practical application on small holding ponds for orchard spray water, livestock water and similar uses.

The pond was constructed in a dug hole about 35 feet by 35 feet square, so that the finished depth averaged 3 feet after the excavated soil was banked and sloped on the perimeter of the hole. It stores about one acre-inch of water. Vinyl plastic material, 8 mils thick, was cemented together with 2-inch wide strips of the same material. The liner was large enough to cover the bottom, up the sides, over the embankment and about 1 foot down the outside slopes. The finished liner was 52 feet by 44 feet. An 18-inch, welded, galvanized culvert was installed with a one-inch pipe connection to the pond for a stilling well and shelter for the water stage recorder to measure evaporation losses. The accompanying figure shows the liner and the stilling well in place. A 4 mil thick polyethylene cover, density about 0.92, was floated on the water surface. It was anchored around the edges of the pond with sand bags.

A control pond, 14 feet by 14 feet and 3 feet deep, was dug a short distance from the larger one and lined with the vinyl plastic material but, to allow free evaporation, no cover was put over the water. A stage recorder was installed.

The evaporation measurements were made during the latter part of September and through October 1956. During this period, evaporation losses from the uncovered pond varied from 0.10 inch to 0.38 inch per day and from the covered pond the loss was 0.045 inch or less per day. The average loss per day from the covered pond was 0.018 inch and from the uncovered 0.190 inch. During a 9-day period in mid-summer about 1500 gallons of water would be lost from an uncovered pond of this size and 135 gallons from a covered pond. The official mean temperature for September was 69.9° and October was 63.8°. Open pan evaporation for September was 4.121 inches and 3.1026 inches for October.

Plastic liner in place in dug pond. Note that a considerable volume of water is above ground surface. Clemson, S. C.

Although the liners used were cemented together at this location, prefabricated sheet made to size would have been more desirable. The number of leaking seams was considerably greater than anticipated, which necessitated on-site patching in the pond.

It is believed that surface and sub-surface sealed ponds of this nature may offer considerable promise for on-the-farm storage of small amounts of water for domestic and livestock uses. Further research is needed however, before definite recommendations can be made.

Kansas

RANGE GRASS WATER USE EXCEEDS RAINFALL

Paul L. Brown, Hays.--An experiment to determine the magnitudes and variation of soil moisture amounts in relation to natural rainfall in Kansas was initiated at Manhattan, Hays, and Garden City in 1956. This is part of a study being conducted in the North Central Region of the United States. All the experimental sites are in native grass.

The Hays site is located on rather level upland areas with uniform soil that do not receive runoff water from adjacent areas and with enough slope to prevent ponding. The experimental areas are 50 feet square and are divided into quarters (blocks) to give four replications.

Soil moisture samples are taken with a soil tube at a randomly selected location in each block on the first day of each month. Gypsum blocks are buried in each replication at randomly selected sites. The blocks are buried at depths of 1-1/2, 4-1/2, 7-1/2, 10-1/2, 18, 30, and 42 inches. Thermistors for determining soil temperatures are buried with the gypsum blocks in one replication. Block and thermistor resistance readings are made each week. The soil is Yocemento (tentative) silty clay loam.

The native grass is a mixture of buffalo grass, Buchloe dactyloides, and blue grama, Bouteloua gracilis, both warm-season grasses. Winter-annual grasses, cheat grass, Bromus tectorum and little barley, Hordeum pusillum, normally emerge in the fall and grow during the spring and early summer. Early spring growth is predominantly winter-annual grasses.

The soil was wet to field capacity to a depth of approximately 26 inches at the beginning of April. Precipitation amounts, water use, predominant vegetative growth, and growth status for the growing season, April through September 1956, are shown in the accompanying table.

During April, cheat grass and little barley grew well and used much of the available water. Precipitation for the month measured 1.25 inches and the water use was 4.10 inches. In May, the growth of wild brome and little barley was curtailed by lack of water. Buffalo and blue grama grass started growth during the month, but the winter-annuals had depleted the soil moisture to the point that the warm-season grass growth was limited. Precipitation for May was 1.42 inches, and water use was 1.99 inches.

In June, the winter annuals matured. Buffalo and blue grama grass became dormant during the month. These two grasses never really got started because of dry soil. Precipitation measured .96 inch, and wateruses was 1.14 inches. Rain in early July caused the two warm-season grasses to green and start growth. Buffalo grass developed stolons four to eight inches in length, but these stolons failed to root because of lack of moisture later in the month. By the end of July, the grass was again dormant and remained dormant for the remainder of the year. Rainfall measured 2.77 inches, and water use was 3.43 inches in July.

August rainfall measured .85 inch, and water use was .99 inch. September rainfall measured .06 inch, and water use was .97 inch. During the enforced dormant period, the grass leaves remained tightly curled, and the leaves gradually dried up beginning at the tip. From a distance, the grass appeared dead, but closer examination showed that the base of the leaf and the stem were alive.

Month	Precipitation	Water use	Dominant vegetative growth	Growth status
	Inches	*Inches*		
April.........	1.25	4.10	cheat grass little barley	Good
May...........	1.42	1.99	cheat grass little barley buffalo and blue grama started growth	Fair. Growth was limited by lack of rainfall and soil moisture.
June..........	.96	1.14	cheat grass and little barley matured, buffalo and blue grama	Poor. Grass dried up during month. There was practically no growth occurring at end of month.
July..........	2.77	3.43	buffalo and blue grama	Early July rains caused grass to green and grow. Buffalo grass developed stolons 6" to 8" in length. Stolons did not root due to lack of moisture. By end of month grass was dormant.
August........	.85	.99	buffalo grass blue grama grass	Grass remained dormant.
September.....	.06	.97	buffalo grass blue grama grass	Grass remained brown and dormant.
Totals......	7.31	12.62		

Precipitation for the growing season measured 7.31 inches, and the grasses used 12.62 inches of water. Stored soil moisture contributed 5.31 inches of moisture. At the close of the growing season, the soil moisture content was at the permanent wilting percentage.

Normal precipitation for the growing season at Hays is 17.60 inches. Precipitation in 1956 was only 42 percent of normal. One-third of the total water use occurred in April at the beginning of the growing season. This water was used by the weedy grasses which are considered to be of little grazing value. The native grasses, buffalo and blue grama, were robbed of needed moisture, and consequently, were never able to grow normally. This situation was typical of the range conditions that prevailed in Western Kansas in 1956.

Idaho

EARLY PLOWING MAINTAINS MOISTURE FOR WHEAT SEEDING

F. H. Siddoway, St. Anthony.--Investigations in 1956 showed that time of plowing can be of considerable importance in obtaining stands of winter wheat. Surface soil moisture

remained adequate on the early plowed land throughout the winter wheat drilling period, which extends from about August 15 to October 1. At no time during this period was there sufficient surface soil moisture present on the land plowed at the later date to obtain even a fair stand of winter wheat.

Winter wheat stands in the Southeast Idaho dryland farming area were generally quite variable this past fall. This was due to below average spring and summer precipitation. Seed could not be planted in moist soil, even with deep furrow drills, to insure satisfactory germination.

Time and depth of plowing, within reasonable limits, have not been considered important factors influencing surface soil moisture conditions at drilling time. Precipitation during the summer months is usually adequate to insure an ample stand of winter wheat. Samples taken on land plowed on two dates and two depths indicate that time and depth of plowing may be a very important management consideration for this area.

Land on the station that was fallowed during 1955 was plowed during two periods centering about May 16 and June 8. The first date was the earliest that soil moisture conditions permitted working the land. By the time the remainder of the land was plowed at the later date, volunteer grain growth had reached a height of approximately 6 inches and annual weed growth a height of about 3 inches. The early plowed land was plowed shallow, about 3 inches deep, and the late plowed land about 5 inches deep. All plowing was done with a sweep plow. The table below lists some quantitative measurements taken on land plowed on the two dates.

Measurement	Early plowed (3" plowing depth)	Late plowed (5" plowing depth)
Depth to moist soil (inches)....................	3.3	5.4
% Moisture, 0-6" depth..........................	8.1	6.0
% Moisture, 6-12" depth.........................	13.2	13.4
Volume weight of soil, 0-6" depth...............	1.14	1.03

There was a sharply defined line between the dry soil and the moist soil as represented by depth to moist soil. Time and depth of plowing influenced the moisture content in the 0 to 6 inch soil layer, but had no apparent effect on the 6 to 12 inch layer. The volume weight difference was due to the difference in depth of plowing.

Although these results were from field sampling rather than a controlled experiment and it was impossible to separate differences due to time of plowing and depth of plowing, they nevertheless indicate that timeliness and depth of plowing are important factors which affect surface soil moisture on fallow land.

Nebraska

TIME BETWEEN CROPS AFFECTS ACCUMULATION OF MOISTURE

F. L. Duley, Lincoln.--Nebraska experienced another drouth year for corn in 1956. Experiments at Lincoln showed the importance of allowing more time between crops to accumulate moisture under such conditions. In some cases, corn followed wheat or second year sweet clover that was harvested for seed in July. On such land there was tall stubble and much residue to prevent runoff or excessive evaporation. Also the residue caught snow and the open soil structure allowed the water to go into the ground. As a result, there was moist soil down into the fourth foot at corn planting time.

Where there was first year sweetclover or weeds on the land, growth continued until freezing weather. The growing plants continued to extract water from the soil until late in the fall. Since the winter precipitation was light, land that had these late-growing crops had moist soil only to about 18 inches at corn planting time.

Land growing corn in 1955 which was intermediate as to time of maturity was also intermediate in the amount of moisture in the soil at planting time.

The beneficial effect of stored moisture in the soil is thus well illustrated by the yields of corn on land having different crops the previous year as shown in the accompanying table.

Yields of corn on land having different crops the previous year, Lincoln, Neb., 1956

Previous crop	Yield per acre		
	Stubble mulched	Plowed	Increase for stubble mulched
	Bushels	*Bushels*	*Bushels*
Wheat or 2nd year sweet clover......................	68.9	62.0	6.9
Corn or medium late crop...........................	28.5	17.3	11.2
1st year sweet clover growing late..................	10.5	2.4	8.1

The advantages of stubble mulching over plowing also shows up well during a dry year. The mean increase over plowing was 8.7 bushels per acre. This result corresponds well with results in other dry years, which have shown an advantage for stubble mulching. This is also similar to results with wheat which show that there is a relative advantage in yields for stubble mulching from sub-humid toward semi-arid conditions.

Nebraska

SUBSOIL MOISTURE ESSENTIAL FOR NITROGEN RESPONSE ON DRYLAND

R. E. Ramig and F. E. Koehler, North Platte.--Dryland corn yields in the Great Plains generally cannot be increased by fertilizing with nitrogen fertilizer unless there is subsoil moisture to a depth of five or six feet at corn planting time. However, in seasons of above normal effective rainfall, such as 1883, 1915, and 1951 at North Platte, the amount of subsoil moisture at planting would not be so important.

Lack of soil moisture limits crop yields for dryland farmers of the Great Plains, and precipitation during the growing season is often poorly distributed and inadequate. This is especially true for corn. Profitable increases in corn yields from applications of commercial fertilizer can only occur when the moisture supply is adequate. No response or even decreased yields may result from fertilizer when moisture is inadequate. Under drouth conditions, the amount of moisture stored in the soil at seeding time may determine the crop production.

Better fertilizer recommendations for dryland corn farmers can be given when the relationship between soil moisture storage at planting time and proper rate of fertilizer are better understood. This relationship was studied at the North Platte Experiment Station during 1954-56--three dry years. The experiment was conducted on Holdrege very fine sandy loam that had been cropped to wheat and corn for the past 80 years. This soil is medium low to low in organic matter and nitrogen.

Late summer tillage of the previous wheat crop stubble to kill weeds and conserve moisture was omitted in order to have the soil wet to a depth of less than two feet when the various moisture depths were established before corn planting. The January through

September precipitation for 1954, 1955, and 1956 was 11.88, 20.21, and 13.06 inches, respectively. The 50 year (1907-1956) average precipitation for the same period is 16.95 inches. Although the 1955 precipitation for this period appears very favorable for corn production, the acutal yields do not support this. The average corn yields of all treatments for 1954, 1955, and 1956 were, respectively, 29.1, 14.8, and 32.8 bushels per acre. These data indicate that several heavy rains in the April 25 to June 25, 1955, period were ineffective for storing soil moisture. Of the 7.97 inches of rain in this period, only 1.85 inches were stored in the soil. The remainder was lost by runoff and evaporation.

In order to simulate different moisture conditions that might result from late fall and early spring rains, some of the test areas were wet to various depths before planting corn. Varying amounts of ammonium nitrate fertilizer were side dressed when the corn was 8 to 12 inches tall. There were two stalks of corn per hill spaced every 40 inches equivalent to 7800 plants per acre.

Corn yields averaged 9 bushels per acre on plots that received no additional water before seeding and no nitrogen fertilizer (Table 1). These plots were wet to a depth of about 2 feet from winter and early spring precipitation. On non-fertilized plots, with the top 4 feet of soil wet to field capacity at seeding time, the yield was 28 bushels. With the top 6 feet wet to field capacity, the yield was 32 bushels.

TABLE 1.--The effect of various levels of soil moisture and nitrogen on yields of dryland corn, North Platte, Neb., 1954-56

Amount of nitrogen applied per acre*	Corn yield per acre		
	Depth of soil wet to field capacity at planting time		
	2 feet	4 feet	6 feet
	Bushels	*Bushels*	*Bushels*
0	9	28	32
20	7	29	41
40	6	31	44
80	6	29	45

*Ammonium nitrate fertilizer side-dressed when corn was 8-12 inches tall.

None of the rates of nitrogen fertilizer resulted in profitable yield increases where the soil was wet to a depth of 4 feet or less at planting time. However, if the soil was wet to a depth of 6 feet before planting, 20 pounds of nitrogen gave a yield of 41 bushels, a 9 bushel increase over the plot receiving no nitrogen. The 40 and 80 pound rates of nitrogen increased yields slightly to 44 and 45 bushels, respectively.

As an average of the three year period, 1954-56, it required 3.64 and 5.68 inches of water in addition to that provided by precipitation to wet the subsoil to 4 and 6 feet, respectively. This amount of water gave an average increase in yield of 22 and 33 bushels per acre over the yield of the unwatered plots.

When soil is filled with water to a depth of 6 feet at corn planting time, increased yields may be expected when 20 to 40 pounds of nitrogen are applied per acre, even though growing season rainfall is below average. Silt loam and clay loam soils will hold 1.5 to 2.0 inches of available water per foot depth. Dryland farmers should use the best methods of moisture conservation during the interval between crops in order to store all possible precipitation in the subsoil by preventing weed and volunteer crop growth after harvest,

leaving plant residues on the soil surface, and using such mechanical practices as contour farming or terracing where recommended.

Crude protein content of the corn was increased by nitrogen fertilizer but decreased with more favorable soil moisture conditions (Table 2). Eighty pounds of nitrogen increased crude protein 1 to 2 percent. Recent work indicates that this increase in crude protein of corn due to nitrogen fertilization results, unfortunately, largely from increases in nonessential rather than essential amino acids. Thus, the increase in crude protein is of little feeding value for non-ruminant animals such as swine or poultry, but may be valuable for cattle and sheep.

TABLE 2.--The effect of soil moisture and nitrogen on the crude protein content of dryland corn, North Platte, Neb., 1954-56.

Amount of nitrogen applied per acre	Crude protein content[1]		
	Depth of soil wet to field capacity at planting time		
	2 feet	4 feet	6 feet
Pounds	*Percent*	*Percent*	*Percent*
0	13.1	10.9	9.9
20	13.6	11.7	11.0
40	14.0	12.4	11.5
80	14.1	12.9	11.6

[1] Calculated on 15.5% grain moisture basis.

TILLAGE AND CULTURAL PRACTICES

Louisiana

DEEP TILLAGE CONTROLS "HOT SPOTS" AGAIN IN 1956

I. L. Saveson, Baton Rouge.--In many of the cotton producing areas of the Mississippi Delta, and particularly of Louisiana, streaks or small areas of cotton suffer severe drought damage if there is any degree of moisture stress during the growing season. These drought-susceptible spots are locally called "hot spots". Preliminary studies indicated they were usually associated with areas having compacted zones in the upper soil profile. Studies of tillage practices to remove or control this condition have been under way at the Northeast Louisiana Experiment Station at St. Joseph.

The deep tillage treatments were made the first of November, 1953 on one set of plots and these same treatments were made in November 1955 on another site. Except for these treatments, conventional shallow tillage has been used in seedbed preparation. In working the area, the "hot spots" or compacted zones were found to occur in streaks or bands diagonally across the field, ranging from 20 to 40 feet in width and approximately 100 feet apart. They were extremely hard.

The residual effects of edging and of lifting were still evident in the third successive cotton crop after treatment. Yields averaged 655 to 912 pounds of seed cotton per acre higher on these plots than on plots receiving only conventional shallow tillage. These treatments gave the land an opportunity to store water from the winter and spring rains. Mixing soil by scarifying resulted in excessive shatter of the soil and compact layers formed again on these soils as soon as they were wet.

Cotton yields in tillage tests on Commerce silt loam, Northeast Louisiana Agricultural Experiment Station, St. Joseph, 1956

Treatment	Seed cotton yield per acre	
	Land treated in 1953	Land treated in 1955
	Pounds	*Pounds*
Mixed by scarifying (Graham Hoeme) 12"............	1,691	2,387
Turned and edged 18"..............................	2,535	3,076
Lifted 18" deep, 18" sweeps, 1 level..............	2,278	3,449
Conventional middle buster........................	1,623	2,488

The treatments made in 1955 showed a gain of 961 pounds of seed cotton per acre for lifting and 588 pounds for edging over the conventional middle buster treatment, and again scarifying had no effect.

These deep tillage experiments indicate that the final results are governed by the amount of recharge of subsoil moisture. More data are needed to evaluate such practices as edging and lifting for increasing soil moisture reserves.

Maryland

RIDGED ROWS INSURE HIGHER TOBACCO YIELDS IN WET YEARS

C. S. Britt and C. S. Slater, Beltsville.--Comparison of ridge rows and flat tilled land for tobacco at Beltsville showed that yield increases on contour-grade ridge rows are confined mainly to years with periods of excess rainfall.

Tobacco was grown in a one-year rotation with a winter cover crop of wheat and vetch. The ridges were made by listing after the whole area had been plowed and disked. Two dry and three wet years, occurred in the test period. Rainfall and corresponding yields for ridged and flat cultivation are given in the table.

Tobacco yields of marketable leaf from ridged and flat rows in relation to dry and wet seasons, Beltsville, Md., 1949-1952

Season	Characterization	Rainfall[1]	Yield per acre		Yield increase for ridging
			Ridged	Flat	
		Inches	*Pounds*	*Pounds*	*Pounds*
1949	dry	7.04	1,178	1,168	10
1951	dry	7.17	824	806	18
1948	wet	11.52	1,188	952	236
1950	wet	18.27	1,251	1,132	119
1952	wet	14.40	1,250	1,152	98

[1] From planting to harvest.

Excessive rain occurred in 1948 between the 31st and 35th days after planting. A somewhat similar wet period occurred between the 6th and 15th day in 1950. In both years adverse effects on the flat planted tobacco were apparent almost immediately. In 1952 several widely spaced wet periods are associated with the lower yield from the flat-cultivated plots.

The tobacco leaves from the ridged and flat plots were the same in quality and price averaged 53. 5 cents per pound. Yield increases amounted to 236 pounds in 1948, 119 pounds in 1950, and 98 pounds in 1952. The annual increase in crop value from the ridged row plots was $55. 00 per acre for the 5-year period, and $80. 00 per acre for the three wet years.

It would appear that ridging the rows would insure high tobacco yields in wet years with no disadvantage to ridging the rows in dry years. Ridged rows should have special value in supplemental irrigation if a heavy rain fell soon after water was applied. Contour ridging also reduces soil erosion and runoff.

SOIL AND WATER MANAGEMENT-GENERAL

Illinois

WATER UPTAKE IS FUNCTION OF SOIL MOISTURE AND MOISTURE TENSION

D. B. Peters, Urbana. --The absorption of water by plant roots is controlled by both moisture content and moisture tension as shown by short-term laboratory experiments.

Germinated seeds placed in soils which had been brought to various tensions show reduced water uptake and reduced root elongation as soil moisture tension increases or as the moisture content per unit tension decreases.

TABLE 1.--Elongation of corn roots as influenced by moisture tension and moisture content (24-hour growth period)

Clay soil in sand-soil mixture	Elongation of corn roots				
	Soil moisture tension (Atmospheres)				
	1/3	1	1.75	3	8
Percent	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
25	35.5	30.5	25.8	19.8	10.8
50	37.6	33.8	30.0	21.1	14.3
75	39.4	35.6	32.1	24.4	16.3
100	41.4	38.8	36.2	28.2	20.6

The data in Table 1 show that the elongation for any one mixture decreases as the soil moisture tension increases. Note also that elongation decreases as the percent of clay in the clay-sand mixture decreases or as the moisture content per unit tension decreases. In Table 2 the data show moisture contents as a function of tension for the various soil mixtures.

Although the test has not been conducted on growing plants, the data here would indicate that management of water economy in the field must also take into consideration the moisture holding capacity as well as the moisture tension.

TABLE 2.--Moisture content as a function of soil moisture tension

Clay soil in sand-soil mixture	Moisture content				
	Soil moisture tension (Atmospheres)				
	1/3	1	3	5	8
Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
25	8.7	6.8	6.0	5.4	4.7
50	14.5	11.3	10.2	9.6	8.5
75	20.5	16.6	15.4	14.5	12.3
100	26.5	21.4	19.8	18.7	16.0

Texas

DRY WEATHER RESPONSIBLE FOR LOW CROP YIELDS IN 1956

E. D. Cook, Temple.--Cotton yields in the crop rotation studies were low this year because of the dry weather. The check plot produced less cotton than any of the other plots in the test. However, this low yield could be attributed to low moisture conditions in the cotton plots in the spring. The rainfall in August of 1955 was 13.78 inches but most of this rainfall was used by the cotton in August and September. The other plots in this test had a chance to store some moisture from the August rains because the land either had been plowed or the crop was not in a growing condition. A poor stand of cotton was obtained on the check plots because of the dry weather.

Counts were made starting on June 28 and ending on August 27 at 7 to 10 day intervals to determine the percentage of plants killed by root rot. The results of these counts are shown in Table 1. Table 2 shows the yield of seed cotton and the percentage loss from root rot. The root rot count made on August 9 was very closely correlated with the percent of loss of cotton.

TABLE 1.--Root rot incidence in rotation studies, Blackland Experiment Station, Temple, Tex., 1956

Rotations	Average percent infestation for three replications by dates						
	June 28	July 3	July 11	July 19	July 30	Aug. 9	Aug. 27
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Oats-swcl, Cotton, Oats-swcl, Cotton..........................	15.3	23.5	30.9	36.0	38.3	39.2	39.5
Fescue-alf, Fes-alf, Cotton, Cotton (2nd year)...............	11.6	14.7	20.0	22.2	23.1	23.6	24.5
Cotton, Oats-swcl, Swcl, Cotton...	8.2	13.3	21.4	26.5	30.6	32.4	32.5
Cotton, Cotton, Cotton, Cotton....	7.2	11.9	15.6	17.5	18.5	19.0	19.2
Cotton, Oats-alf, Alfalfa, Cotton.	7.2	11.6	19.2	23.5	29.6	31.4	31.4
Cotton, Fes-alf, Fescue-alf, Cotton (1 year).................	5.3	9.3	15.6	18.2	19.8	21.2	21.5
Cotton, Cotton, Fes-alf, Fes-alf, Cotton (1st year)...............	5.0	7.5	12.3	14.4	15.6	16.8	17.1
Oats, Cotton, Oats, Cotton........	3.2	4.8	6.2	7.3	8.4	8.8	9.0

TABLE 2.--Cotton yields and incidence of root rot in rotation studies, Blackland Experiment Station, Temple, Tex., 1956

Rotations	Incidence of root rot	Pulled cotton per acre		Yield reduction
		With root rot	Without root rot	
	Percent	*Pounds*	*Pounds*	*Percent*
Cotton, Oats-swcl, Swcl, Cotton.....	32.5	838	1,263	33.7
Cotton, Oats-swcl, Cotton..........	39.5	754	1,334	43.5
Cotton, Cotton, Fes-alf, Fes-alf, Cotton..................	17.1	972	1,183	17.9
Cotton, Oats-alf, Alfalfa, Cotton...	31.4	923	1,234	25.3
Cotton, Oats, Cotton................	9.0	983	1,292	24.0
Cotton, Cotton, Cotton.............	19.2	365	740	50.7
Fes-alf, Fes-alf, Cotton, Cotton....	24.5	637	915	30.4
Fes-alf, Fes-alf, Cotton (1 yr).....	21.5	833	1,278	34.9

Oat yields were also low for this year. The highest oat yields were produced on plots that were in corn the year before. The oat yields following cotton were lower than following corn with the exception of the rotation of corn and oats. The results of this test are shown in Table 3. There was a poor stand of alfalfa and sweetclover in the plots.

The highest yield of corn was from the plots that had been in oats the year before. This was also true for 1955. However, in 1955 the yield from the check plot was second highest but in 1956 it was the lowest. The results of this test are shown in Table 4.

The forage yields were very low, with alfalfa and sweetclover plots producing the most forage. However, the forage yields in these plots were not from the alfalfa and sweetclover but from the volunteer oats that came up in these plots. The results of this test are shown in Table 5. Fescue-alfalfa following either cotton or corn produced less forage than any of the other crops in this test.

TABLE 3.--Oat yields in rotation studies, Blackland Experiment Station, Temple, Tex., 1956.

Rotations			Average yield per acre
1954	1955	1956	
			Bushels
Alfalfa,	Corn,	Oats-alf	42
Swcl,	Corn,	Oats-swcl	39
Oats-swcl,	Corn,	Oats-swcl	36
Oats-swcl,	Cotton,	Oats-swcl	34
Oats,	Cotton,	Oats	31
Swcl,	Cotton,	Oats-swcl	31
Alfalfa,	Cotton,	Oats-alf	31
Oats,	Corn,	Oats	23
L.S.D.			9

TABLE 4.--Corn yields in rotation studies, Blackland Experiment Station, Temple, Tex., 1956.

Rotations	Average yield per acre
	Bushels
Oats, Corn, Oats, Corn	40.5
Oats-alf, Alfalfa, Corn	38.2
Corn, Oats-swcl, Corn	31.2
Oats-swcl, Swcl, Corn	31.7
Corn, Fes-alf, Fes-alf, Corn	22.2
L.S.D.	9.6

TABLE 5.--Forage production in rotation studies, Blackland Experiment Station, Temple, Tex., 1956

Rotations			Air dry forage per acre
1954	1955	1956	
			Pounds
Corn	Oats-swcl	Swcl	1,835
Cotton	Oats-alf	Alfalfa	1,580
Cotton	Oats-swcl	Swcl	1,475
Cotton	Fes-alf	Fes-alf (Fes-alf)	1,470
Corn	Oats-alf	Alfalfa	1,435
Cotton	Fes-alf	Fes-alf (1 yr)	1,100
Corn	Fes-alf	Fes-alf	1,050
Cotton	Cotton	Fes-alf	1,025
Fes-alf	Corn	Fes-alf	1,005
Fes-alf	Cotton	Fes-alf	975
L.S.D.			262

Colorado

GRAIN SORGHUM ROW SPACING, ROTATION STUDY STARTED

B. W. Greb, Akron.--Continued drought conditions, wheat allotments, and the introduction of better adapted grain sorghums has stimulated a significant shift of large acreages of land to sorghum in the central Great Plains during the last three years.

In March, 1956, an experiment was designed and field plots surveyed for a row spacing-sorghum sequence interaction study to determine requirements of growing sorghum to provide adequate control of wind erosion and optimum efficiency in use of soil moisture for this area.

The field treatments include four methods of planting: listed 42 inches wide, drilled 42 inches wide, drilled 28 inches wide, and drilled 14 inches wide. Each of the four methods of planting will be used on sorghum after sorghum, sorghum after fallow, and sorghum after summer fallowed winter wheat.

A total of 72, 3 by 9 rod plots including sorghum, winter wheat, and fallow have been divided into three replications on a Weld silt soil of 0.5 to 1.0 percent slope. The land has been cultivated since 1918. Sorghum was harvested from the experimental area in 1955, thus, the plantings in 1956 were on uniformly cropped land. The first results involving all sequences will be obtained in 1957.

Acute drought conditions during the early and latter periods of the growing season resulted in poor and immature crop growth during the 1956 season, thus, no yields were taken.

HYDROLOGY-GENERAL

Texas

SOIL MOISTURE AND RAINFALL-RUNOFF CORRELATED

M. A. Hartman and R. W. Baird, Riesel.--One of the studies now in progress at Riesel is the correlation of antecedent soil moisture with the rainfall-runoff relationship.

This first study was made with data from a 2.97-acre native grass area on a fairly uniform Houston Black Clay soil. Average soil depth is 59 inches and average slope is 3.8 percent. Data include rainfall, runoff and soil moisture records.

Soil moisture prior to each storm was computed from soil moisture determinations adjusted for evapotranspiration as discussed in Quarterly Report No. 10 July-September 1956. Soil moisture was computed and expressed as inches of available soil moisture in the upper 3 feet of soil.

The rainfall-runoff relationship was expressed numerically by use of the family of curves of rainfall versus runoff prepared by Victor Mockus and given in ES 1001 in "Design Hydrographs" SCS Engineering Division, Washington, D. C., June 1956. Observed rainfall and runoff for each storm were used in ES 1001 to find the proper curve. Curve numbers thus determined from ES 1001 were used as numerical expressions of the relationship between rainfall and runoff. In this initial study only those storms causing more than 0.1 inch of runoff were used. Since soil and land use were constant, all variations in curve numbers were attributed to antecedent moisture effects.

A good correlation, r = .867, was found between the rainfall-runoff relationship and antecedent available moisture in the upper 3 feet of soil. The equation for the 38 items in this set of data was:

$$X = 9.3\,y + 16.5$$

wherein

X = curve number from ES 1001.

Y = inches of available moisture in upper 3 feet of soil just prior to storm.

Michigan

WIDE USE MADE OF WATERSHED DATA

N. C. Cottom, -E. Lansing.--Activities of this project during the last quarter of 1956 have mainly been the continuation of the day-to-day gathering of hydrologic data from the installations at the three watersheds. These and other data have been furnished cooperating agencies for their use, and the U. S. Weather Bureau for publication and use in its studies. Hydrologic and meteorologic data were also furnished the Geologic Survey, as well as to several departments and graduate students at Michigan State University for use in research or for theses.

Ohio

PERCOLATION REDUCED BY DEEP-ROOTED CROPS

F. R. Dreibelbis and L. L. Harrold, Coshocton.--Records from two monolith lysimeters, as presented in the accompanying table, show that the average annual percolation through an 8-foot soil profile was about 5 inches less for alfalfa-bromegrass than for bluegrass--poverty grass mixtures.

The two lysimeters had the same bluegrass--poverty grass cover during the 5-year period 1943-47. Annual percolation from the two lysimeters was nearly the same during this period, averaging 11.42 inches from Y101B and 11.95 inches from Y101D.

An alfalfa--bromegrass mixture was established on lysimeter Y101D in 1948 while Y101B was retained under cover of bluegrass and poverty grass. For the 9-year period 1948-56, percolation averaged 11.65 inches from the lysimeter with shallow rooted grasses and 6.59 inches under deep rooted cover.

Increased consumptive use of water by the alfalfa--bromegrass appears to be responsible for the observed average difference in percolation from these lysimeters. The shallow-rooted bluegrass and poverty grass used moisture from only a relatively shallow depth and when the available soil moisture was exhausted evapotranspiration was

greatly reduced. The deep-rooted vegetation, on the other hand, continued to use water at high rates throughout the growing season, obtaining it from a greater depth of soil.

Evapotranspiration values for Y101D appear in column 4 of the accompanying table. Y101B is not equipped to record weight changes from which evapotranspiration can be calculated. On Y101D, evapotranspiration averaged 28.48 inches per year for the period of shallow-rooted vegetation and 34.35 inches for the period of deep-rooted vegetation.

Effect of shallow- and deep-rooted vegetation on percolation, 1943-56

Year	Annual lysimeter percolation		Y101D Evapo-transpiration
	Y101B[1]	Y101D[2]	
	Inches	*Inches*	*Inches*
1943	10.86	12.60	No record
1944	6.76	7.11	24.08
1945	15.39	15.35	27.17
1946	11.68	9.80	33.56
1947	12.39	14.85	29.11
Average	11.42	11.95	[3] 28.48
1948	10.49	5.61	32.54
1949	11.24	5.58	37.36
1950	18.41	8.99	36.94
1951	14.96	13.41	37.19
1952	12.51	8.80	35.69
1953	8.12	1.53	31.90
1954	6.24	0	31.99
1955	8.40	1.70	36.00
1956	14.50	13.73	29.51
Average	11.65	6.59	34.35

[1] Shallow-rooted poverty grass, 1943-56.
[2] Shallow-rooted bluegrass 1943-47; deep-rooted alfalfa-bromegrass, 1948-56.
[3] 4-year average.

Virginia

RUNOFF IS LOW FROM STEEP MULCHED-TILLED WATERSHEDS

J. B. Burford and J. H. Lillard, Blacksburg, Va.--Three small contour strip-cropped watersheds located adjacent to each other have been gaged since 1951. They receive the locally developed double-cut plow method of mulch tillage each year on the corn strips of the corn, small grain, hay rotation.

The mulch materials consist of the hay stubble, the wheat straw following combining, and all grass and legume growth occurring after the removal of the first hay cutting. These mulch materials are distributed about equally in the top three inches of soil and on the surface by the tillage operations for corn.

The watershed soils are of limestone and shale origin. They are loams and silt loams of the Groseclose, Lodi, and Litz series which have moderate to moderately rapid

permeability. The predominating slopes are steeper than recommended for cultivated crops where conventional tillage practices are used.

The physical characteristics, rainfall and runoff yield data for these watersheds are summarized in the following table:

Watershed	W-IV	W-V	W-VI
Size--acres	3.49	6.08	7.70
Percent of watershed in slope class:			
B (2 to 8%)	60	25	16
C (8 to 15%)	2	40	41
D (15 to 25%)	38	35	43
Length of record--years	5	5	5
Annual precipitation--inches:			
Maximum year	39.52	39.52	39.52
Minimum year	29.54	29.54	29.54
Average year	34.76	34.76	34.76
Annual runoff--inches:			
Maximum year	0.44	0.17	0.56
Minimum year	0.02	0.02	0.13
Average year	0.14	0.07	0.31
Average runoff as percent of average precipitation	0.41	0.21	0.88

These low surface water losses from steep lands indicate the effectiveness of vegetative cover and mulches when properly used in reducing runoff. The only instances of appreciable volumes of runoff or high peak rates are those where the soil profile was saturated from antecedent rainfall at the time of the record storm.

The data in the following table indicate that antecedent moisture conditions may have a greater effect on runoff rates than rainfall intensities under this type of land use and tillage.

The nine-day period covered by the storms listed in the table includes the greatest concentration of high intensity storms during the five years of records. The storms of July 30 fell on very dry soil and caused only a trace of runoff. The next three storms, which were of low intensity, did little more than offset normal evapotranspiration.

The record high intensity storm of August 5 failed to produce record runoff peaks because the soil profile was not filled to capacity at the beginning of the storm. However, its 1.86 inches of rain plus another 0.98 inch on August 7 fully saturated the soil so that a lower intensity storm on August 8, produced the record peak rate and yield of runoff.

Intensity duration	Storm of 7/30/52	Storms of 7/31/52	Storms of 8/1/52	Storm of 8/2/52	Storm of 8/5/52[1]	Storms of 8/7/52	Storm of 8/8/52[2]
Minutes	Intensities--inches per hour						
2	5.70				8.10	2.40	4.80
5	4.08				6.84	1.92	3.60
10	2.88				5.22	1.26	3.00
15	2.48				4.68	0.96	2.80
20	2.01				3.87	0.96	2.19
30	1.34				2.74	0.88	1.59
60	.85				1.76	0.70	1.28
120	.54				--	0.44	0.68
Total rainfall--inches	1.19	[3] .32	[3] .11	[3] .40	1.86	.98	1.61
Watershed	Peak discharge c.f.s./acre						
W-IV	Trace	None	None	None	0.27	.01	0.55
W-V	Trace	None	None	None	0.21	.07	0.45
W-VI	0.04	Trace	None	None	0.48	.03	0.62

[1] The storm of 8/5/52 gave the maximum intensities for the 2, 5, 10, 15 and 20 minute durations for the 5-year period of record.

[2] The maximum peak discharges for the 5-year period for all three watersheds occurred during the storm of 8/8/52.

[3] Totals shown for 7/31/52, 8/1/52 and 8/2/52 are the combined rainfall from two or more storms of very low intensities.

Florida

ONCE-IN-LIFETIME STORM HITS FLORIDA WATERSHEDS

J. C. Stephens, Ft. Lauderdale.--A low pressure area moving northward along the east Florida coast on October 14-16 brought strong winds and torrential rains to a 50-mile strip almost the entire length of the state. Storm rainfall varied from about 3 inches south of Lake Okeechobee to as much as 20 inches at scattered points in the Kissimmee-St. Cloud area.

Flood waters following the rains inundated the towns of Kissimmee, Taft, St. Cloud and Fellsmere, blocked roads and washed out several bridges in the area east of the Kissimmee River from about Lake Okeechobee north nearly to Orlando. The maximum stream stages ever observed were recorded over sections of the storm area.

Three experimental watersheds operated by the Watershed Hydrology Section were within the heaviest storm area. Frequency indices predict a 24-hour storm of this magnitude can be expected once in about a 50- to 100-year period. A graphical analysis for this storm has been prepared for all three watersheds, including isohyetal maps, discharge hydrographs, and mass curves of runoff.

The Taylor Creek experimental watershed is a broadleaf shaped basin roughly 15 miles long by 8 miles wide with a southeast drainage aspect. It lies in the central part of the state and drains into Lake Okeechobee. Elevations range from about 70 feet mean sea level in the north to 25 feet at the lower gaging site. The area contains a number of ponds

and sloughs and the topography is relatively flat sloping to Taylor Creek and its tributaries. Soils are sandy and there is little surface runoff until they become saturated. Land use is largely range and pasture of which about one-third is classed as improved.

A stream gage located on the northernmost tributary of Taylor Creek forms a sub-area of 10,000 acres. Topography, soils, and drainage for this smaller watershed are similar to the larger.

Both watersheds generally represent areas of low relief with largely natural drainage in the southern Flatwoods of Coastal Plain.

The Indian River Farms experimental watershed is a drainage district, roughly triangular, about 24 miles wide by 14 miles long draining east into the tidal Indian River. The topography is flat, nearly all the area being in the 0 to 2% slope class. The entire watershed is a well maintained drainage district of low relief shielded from outside surface inflow by perimeter dikes, and drained internally by a 420 mile network of canals. Runoff occurs through 3 main outfall canals. Soils are usually classed as somewhat poorly drained sands under natural conditions, but under artifically lowered water tables, internal drainage ranges from medium to very rapid. Land use in the district is about 40% in citrus groves, 30% in improved pasture, and 30% in unimproved range and forest. The Indian River Farms watershed generally represents areas of low relief with improved gravity drainage in the southern Flatwoods of Coastal Plain.

The following table gives a comparative summary of the storm analysis data of each of the three watersheds.

	Indian River Farms Drainage District	Taylor Creek (total area)	Taylor Creek (sub-area)
Area:			
Acres........................	50,000	63,000	10,000
Square miles................	78	98	16
Antecedent rain (2 weeks prior to storm):			
Inches......................	3.96	3.10	1.81
Storm rainfall:			
Inches......................	8.5	8.7	11.0
Duration:			
Hours.......................	18	20	20
Peak flow:			
c.f.s.......................	4,739	6,906	2,525
Lag time:			
Hours.......................	8	36	12
Peak flow rate:			
c.f.s./square miles.........	61	70	160
Total rainfall 10/13-10/30			
Inches......................	10.84	9.78	11.67
Total runoff from area 10/13-10/30			
Inches......................	7.79	8.88	8.76

Nebraska

LESS RUNOFF FROM PREDOMINATELY CONSERVATION FARMED WATERSHED

John A. Allis, Hastings. --South central Nebraska, as in many areas in the Great Plains, was hit by drouth again in 1956. In the past three years Rosemont, Nebraska, has received the equivalent of only two years of average rainfall, or a deficit of about 24 inches in the 3-year period. Not since 1951, the year of the Kansas flood, has rainfall been above normal. The past four years are the only four consecutive years with below 20 inches precipitation in the long-time period of record in this area.

There are many areas to the south and west that have received less rainfall than south central Nebraska in 1956. However, with the meager 13.26 inches measured at the Rosemont meteorological station, some interesting figures have been obtained on runoff. On a 481-acre, straight-row, mixed-cover watershed there was 1.36 inches of runoff in 1956 as compared to 0.65 inch on a 411-acre watershed which is predominantly conservation farmed. This saving of 0.71 inch of runoff, a difference of more than 50 percent between the two watersheds, is very significant, especially in a dry year.

During the past ten years there has been an average of 3.26 inches runoff from the straight-row watershed as compared to 2.43 inches from the predominantly conservation watershed. This is an average saving of 0.93 inch moisture per year.

SEDIMENTATION

Kansas

SEDIMENT YIELD IN GRAZING AREA IS 3.48 TONS/ACRE/YEAR

H. G. Heinemann, Lincoln, Nebraska. --The following "Summary of Data on Kahola Reservoir" is a revision of the tentative sedimentation data for this reservoir, which appeared on page 56 of the May 1955 issue of this publication. No adjustment was made for probable trap efficiency during the storage period.

The contributing watershed is in the "Bluestem-Hills" section of Morris and Chase counties in eastern Kansas. About 85 percent of the watershed is in pasture or rangeland.

Summary of data on Kahola Reservoir

	Quantity	Unit
Age:		
Date storage began--December 1, 1936		
Average date of survey--April 15, 1954		
Years	18.3	Years
Watershed area:		
Including reservoir area	15.9	Sq. miles
Excluding reservoir area	15.3	Sq. miles
Reservoir:		
Area at spillway stage:		
Original	409	Acres
At date of survey	409	Acres
Storage capacity to spillway level:		
Original	6,500	Acre-feet
At date of survey	5,944	Acre-feet

	Quantity	Unit
Reservoir--Continued		
Storage per square mile of drainage area:[1]		
Original	409	Acre-feet
At date of survey	374	Acre-feet
Sedimentation:		
Total sediment	556	Acre-feet
Average annual accumulation:		
From entire drainage area	30.4	Acre-feet
Per square mile of drainage area:[2]		
Volume	1.99	Acre-feet
By weight	2,230	Tons
Per acre of drainage area:[2]		
Volume	135	Cubic-feet
By weight	3.48	Tons
Depletion of storage:		
Loss of original capacity:		
Per year	0.47	Percent
To date of survey	8.55	Percent

[1] Including area of reservoir.
[2] Excluding area of reservoir.

HYDRAULICS

Minnesota

EQUATIONS ARE DEFINED FOR WEIR FLOW IN HOOD INLET

Fred W. Blaisdell, Minneapolis.--Analysis of the hood inlet data has shown that the head-discharge equation for weir control at the square-edged hood inlet can be expressed by the equation

$$\frac{Q}{D^{5/2}} = \left(1.83S^{1/15} + 0.60\frac{h}{D}\right)\frac{a}{A}\sqrt{\frac{h}{D}}$$

and for the well-rounded inlet by the equation

$$\frac{Q}{D^{5/2}} = \left(1.83S^{1/15} + 1.35\frac{h}{D}\right)\frac{a}{A}\sqrt{\frac{h}{D}}$$

These equations are valid between $\frac{h}{D} = 0$ and $\frac{h}{D} = 0.8$. At higher heads the curve should be extended in the same general direction it takes at lower heads and should not follow the reverse curvature given by the equation.

In these equations Q is the discharge in cubic feet per second, D is the pipe diameter in feet, S is the line of the conduit slope, h is the head over the invert at the inlet, a is the conduit wetting area corresponding to h, and A is the area of the conduit. King's "Handbook of Hydraulics," Second Edition, gives values of $\frac{a}{A}$ for various values of $\frac{h}{D}$. (Fourth Edition, Table 84, gives derivation of values of $\frac{a}{D}$ for various values of $\frac{D}{d}$, a ratio comparable to $\frac{h}{D}$ in the above equations).

The first draft of a report covering the hood inlet studies was completed. This report will eventually appear in Technical Paper No. 20-B of the St. Anthony Falls Hydraulic Laboratory as Part X of the closed conduit spillway series of reports.

Minnesota

HYDRAULIC GRADE AFFECTS DISCHARGE OF CLOSED CONDUITS

Fred W. Blaisdell, Minneapolis. --The hood inlet study provided considerable data regarding the position of the hydraulic grade line at the conduit exit and these were analyzed. The exit position of the hydraulic grade line varies with the discharge from well above the centerline at low flows to well below the centerline at high flows when the outlet discharges freely. Particularly in the case of large conduits and low total heads, the position of the hydraulic grade line significantly and detrimentally affects the discharge. The results will be presented in a technical paper.

Minnesota

ADDITIONAL STUDIES PLANNED ON CLOSED CONDUIT SPILLWAYS

Fred W. Blaisdell, Minneapolis. --Robert V. Keppel, who is now Supervisor of the Southwest Watershed Studies, spent the quarter checking the computational methods and reviewing the rough drafts of reports covering all tests conducted on closed conduit spillways at the St. Anthony Falls Hydraulic Laboratory since 1940. He also reviewed data on field tests, some of which were obtained in the 1930's. These reports are now being prepared for reproduction as Parts II to IX of the closed conduit spillway series. They will appear as Technical Papers 18-B and 19-B of the St. Anthony Falls Hydraulic Laboratory.

Plans were made for conducting additional tests on the hood inlet as requested by the Soil Conservation Service at a planning conference held in late October. These tests will be on drop inlets used in conjunction with the hood inlet.

Oklahoma

COTTON TESTED FOR FLOW RETARDING CHARACTERISTICS

W. O. Ree, Stillwater. --A good stand of cotton planted in 40-inch rows was tested to determine its flow retarding properties. The tests were made on a crop planted in one of the large experimental waterways. It was found that Manning's n ranged from 0.036 for flows 3 inches deep, to 0.13 when flows were about 2 feet deep. The increase in the retardance coefficient was attributed to the increasing leafiness of the plant at the greater depths. Flow depths submerging the plants were not reached. If they had been, the value of Manning's n would have started downward again.

Oklahoma

BROADCAST SUDANGRASS HAS HIGH FLOW-RETARDING PROPERTIES

W. O. Ree, Stillwater. --Tests on a very dense stand of broadcast sudan grass showed Manning's n to range from .33 for flows 9 inches deep, to about .10 for a flow three feet deep. The value of the retardance coefficient decreased with increasing flow depth. Contrast this with the cotton which showed the opposite effect. The difference is due to the different physical characteristics of the vegetation. The sudan grass had the greatest volume of plant material near the base of the plant.

Oklahoma

INTERMITTENT FLOWS UNHARMFUL TO WATERWAY

W. O. Ree, Stillwater. --A bermuda grass-reed canary grass channel was subjected to three wet and dry cycles of 5 days of continuous low flow and 15 days of no flow. At the end of this period of treatment the channel was tested to evaluate the protective ability of the cover. The tests showed that this flow experience had not harmed the vegetation. In fact, the water served to irrigate the grass and produce a very good cover. Data analysis is not complete but the appearance of the channel indicates that the permissible velocity for this soil-cover combination was not adversely affected by the treatment.

Oklahoma

ORIFICE METER WILL INCREASE EFFICIENCY OF MODEL TESTING

W. O. Ree, Stillwater. --The installation of the 12-inch water supply line, with orifice meter, has been completed. This line provides the water for one of the model basins. Its addition will increase the efficiency of the laboratory in its model testing work. A calibration of the orifice plates was made using the model basin as a volumetric measuring tank. The orifice coefficients for the 5 plates (orifices 1-1/2, 2-1/2, 4, 6, and 8 inch diameter) were found to follow closely the curves shown in Engineering Hydraulics by Rouse. Arrangements have been made with the computing center of Oklahoma A & M College to calculate the rating tables. This involves the use of the IBM 650 computor and will be a new experience for the laboratory staff.

LIST OF RECENTLY PUBLISHED PAPERS AND PUBLICATIONS

Some of the recently published papers and publications written solely or jointly by staff members of the Soil and Water Conservation Research Division are listed below.

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